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Progress in Shipbuilding

AFTER months of disheartening delays American shipyards are beginning to strike their gait. Most of the preliminary work begun last year in establishing new yards has been completed and construction of vessels on the new ways is now rapidly forging ahead. Before this issue reaches our readers the first vessel from the new government assembling yards will have been launched by the Submarine Boat Corporation at Newark, N. J. The wooden shipbuilders are now setting a pace of one ship a day. During April the American merchant marine was increased at the rate of a little over 9,000 tons a day, making the total output for the month 240,000 deadweight tons. In the first twenty-three days of May twenty-nine merchant vessels were completed, totaling 174,662 tons. Up to May 11 a total of 159 vessels of 1,108,621 tons had been completed in American shipyards, so that the first million tons of shipping built under the direction of the United States Shipping Board has been placed in service. More than half of this tonnage was delivered since the first of this year and the monthly output is steadily increasing. With continued improvement in the delivery of shipbuilding materials and satisfactory handling of the labor, housing and transportation problems, it will not be surprising if the total output of merchant tonnage from American yards for the year passes the 3,000,000 mark and approximates 4,000,000 tons.

With the expectation of increasing the output from 50 to 60 percent during the coming year Director-General Schwab is encouraging the expansion of existing shipyards and the establishment of new ones. The yards on the Lakes will have an opportunity to increase their output by a million tons and contracts will probably be placed with Pacific yards for at least a million and a quarter additional tons. There will be no reduction of wooden shipbuilding. On the contrary contracts for wooden ships of the Daughtery and Ballin types will be doubled. All of the steel yards on the Atlantic and Gulf coasts will be given all the work they can handle and in many cases the facilities at the yards will be increased. At the Bethlehem Steel plant at Sparrows point, $2,000,000 (£410,000) will be expended immediately for building four new ways and the working force will be increased by at least 4,000. The Newport News Shipbuilding & Dry Dock Company, which has over $100,000,000 (£20,500,000) worth of Government work under contract, is making improvements and extensions at a cost of nearly $6,000,000 (£1,230,000). This yard now employs 9,500 men, which will be increased to 12,000 by the end of the year and to 15,000 within a year. Five government yards for concrete construction will soon be established. A fleet of barges aggregating 775,000 tons and over a hundred tugs will also be built. With the vast amount of work contracted for or pending there is only one answer that the shipbuilders can give—that is, increased efficiency and speed. The outcome of the war depends upon it and it will be forthcoming, we believe, in full measure.

Reduction of Merchant Shipping Losses

SINCE October, 1917, the tonnage of merchant steamships of 500 gross tons and over entering and clearing British ports from and to ports overseas (except coastwise and cross-channel) has averaged nearly 7,000,000 tons a month, and in March exceeded this figure. The losses of British, allied and neutral tonnage during the last five quarters (beginning with January, 1917) has been as follows: 1,619,373; 2,236,934; 1,494,473; 1,272,843 and 1,123,510, which shows a steady decrease during the past year. In recent months the decrease has been even more marked, the highest being 893,877 tons in April 1917 and the lowest 305,102 in April 1918. Comparing these figures, which were supplied by the British Admiralty, with shipbuilding reports from the allied countries it is apparent that ships are now being built faster than they are being destroyed by the German submarines. Moreover, the rate of destruction of the submarines themselves has steadily increased during recent months. This outcome, confidently predicted months ago by American naval authorities, is confirmed in the recent speech of the British Premier. When the history of the allies' warfare against the submarine is made public the deeds of both naval and merchant officers and crews will form one of the most brilliant chapters in marine annals. At the present time it can only be said that the work of these brave men is held in the greatest veneration and with just pride by the nations they are serving.

Shipbuilding Rivalry

NO better incentive for speeding up shipbuilding could be offered than the keen rivalry which now exists among the shipyards for establishing new records in fabricating, assembling and launching vessels for the Emergency Fleet. Foremost among the records made last month was the building of the 5,000-ton collier *Tuckahoe,* by the New York Shipbuilding Corporation in Camden, N. J., in the phenomenal time of 37 days. Under the expert direction of Thomas Mason, superintendent of the yard, this vessel was launched 27 days after the keel was laid and delivered to the Government completed in 37 days. This feat establishes a world's record in vessel construction, the best previous record in this country having been made at the Skinner & Eddy yard in Seattle, where the 8,800-ton steel freighter *West Lianga* was launched 55 days after laying the keel and completed in 71 days after construction was started.

New records in riveting are being established every week, and in this work shipbuilders in Great Britain are at present setting the pace. The latest record at this writing is held by a workman at the Vickers Naval Construction Works at Barrow, who drove 5,804 rivets in nine hours. Closely following this, word comes from a San Francisco shipyard claiming a record for one of its workmen of 5,629 rivets in nine hours, exceeding the best previous record in this country made by Charles Knight, a negro employed at the Bethlehem Shipbuilding plant at Sparrows point, Md., who drove 4,875 rivets in nine hours. Records are also constantly being made in other kinds of work, such, for instance, as the laying of the keel of a 3,000-ton wooden vessel in 1 minute and 45 seconds after a vessel had been launched from the same shipway, at a yard of the Foundation Company on the Pacific Coast.

While such spectacular achievements are not an exact gage of the extent to which shipbuilding work is being speeded up, nevertheless they show what can be done under the conditions where every energy is directed to reducing the time for building a ship, and, therefore, should be encouraged in every possible way.

The Juniors' Prize Papers

NOW is the time for the junior members of the Society of Naval Architects and Marine Engineers to collect material for the preparation of scientific papers to be entered in competition for the hundred dollar prize offered by H. L. Aldrich, associate member of the Council of the Society of Naval Architects and Marine Engineers, for the best paper written by a junior member of of the society for its annual meeting in November. All papers entered in this competition must be completed and delivered to the secretary of the society on or before October 15. As the prize will be awarded to the author of the best paper submitted, or divided into two or possibly three prizes, as may seem best, depending upon the quality of the papers submitted, it is anticipated that the competition will be keen. The papers are not limited to any definite subjects, but may deal with any phase of shipbuilding or marine engineering, either merchant or naval. A wide field is, therefore, open for junior members of the society to develop ideas which will prove of real value in the development of shipbuilding.

Concrete Ships

THAT concrete shipbuilding will form an important part of the Government shipbuilding programme seems assured by the success which has attended the recent trials of the 5,000-ton concrete steamship *Faith* now in service on the Pacific coast. Reports from the official trials of this vessel indicate that the expectations of the builders will be fully met as to the strength of the reinforced concrete hull to resist the stresses imposed by service in the open sea. The vessel not only exceeded her contract speed by over a knot but developed the further advantage in a very appreciable reduction of vibration in the hull. As a result the builders of this vessel have been awarded a contract for a 7,500-ton ship of similar construction.

Contracts have now been placed by the Shipping Board for a total of 58 concrete vessels, aggregating 417,500 tons, at an approximate cost of $42,250,000 (£8,670,000). Forty of these vessels are of 7,500 tons and will be built in five Government yards.

LETTER TO THE EDITOR

Wooden Auxiliary Schooners

There has been much talk and much criticism in connection with the building of wooden auxiliary schooners. Making use of the space kindly offered me by the editor of this paper, I venture to make a few remarks from a *commercial* point of view.

From our own personal experience we know what splendid service the wooden sailing vessels rendered years ago. As an example, in the eighties, one of these ships, a clipper of 2,800 gross tons, carrying 27,000 barrels of petroleum, made a record trip from New York to Antwerp, and from Quebec to London in twelve days. On account of the immense shortage of tonnage, wooden ships are again called upon. The idea of installing reliable crude oil engines in sailing vessels has been carried out and the engines have given very good results in steel square riggers, as well as steel fore and aft schooners, and should easily be advantageously adopted for the *wooden* schooners.

This combination, however, points to a matter which is of utter importance, namely—*workmanship*. Owing to the immense demand for tonnage, yards have been established and the work has been carried on by non-competent and in some cases unreliable men. This circumstance has caused more trouble than many seem to realize. The results are not only inferior work, making use of green timber, bad rigging and poor installation of engines, etc., but the immediate result has been that the yards have gone into bankruptcy, thereby causing incalculable delays, increased cost of the vessels and all kinds of trouble.

In many cases, where foreign enterprise, such as Scandinavian, has been left to the judgment of their agents in this country, severe losses have been the result, owing to circumstances mentioned above. Personally, I know of not less than three yards which went into bankruptcy proceedings, being absolutely unable to fulfill their contracts. The foreign owners have thus been forced to take the yards over and complete the vessels at considerably increased cost.

As pointed out before, there is no reason why the wooden auxiliary schooners should not prove a first-rate useful cargo vessel. Extraordinary circumstances should, however, be kept in mind, such as the use of green timber in many of the vessels, and it consequently would be advisable for the first two or three years to employ the vessels in a suitable trade. As such, there is none as suitable as the Pacific and the Eastern trade. I look upon the wooden schooners as the most useful tonnage in the trade between Pacific ports and Australia, the Hawaiian Islands, and the Far East, preferably, though, in a trade where they do not have to cross the equator. They will thus be able to release for the *transatlantic* trade the tonnage so badly required—fast-going steamers.

The auxiliary wooden schooner possesses many advantages, such as a comparatively small crew, seaworthiness in most kinds of weather and economy in operation. As regards the latter, however, much depends upon the rate of insurance, and the insurance companies will have to alter their opinion of the quality of these vessels. Practical results obtained in the trade will soon prove the efficiency of the wooden schooners, which no doubt will form one of the great helping factors in winning this war.

Seattle, Wash. FRIDTJOF BRYDE.

Merchant Shipping for the War and After

Discussion at Convention of National Foreign Trade Council in Cincinnati Centers on Ships and Shipping

THE one most important matter discussed at the convention of the National Foreign Trade Council, held in Cincinnati, on April 18, 19 and 20, was ships; and the manner in which this was evidenced was conclusively convincing of the fact that American business men are at last awake to the vital necessity of more and more shipping. With President James A. Farrell, of the United States Steel Corporation, chairman of the Council, presiding, and about 1,400 of the leading business executives of the country attending and participating in the business of the convention, nearly every subject discussed touched upon shipping in one form and at some angle; while the third general session, that of Friday, April 19, was devoted exclusively to the subject of the American merchant marine.

Men familiar with foreign trade conditions, and with the peculiar needs of given industries, told the members of the Council how the business of this country abroad after the war will depend very largely upon the extent to which the construction of an adequate merchant fleet is taken care of. Such details as the fostering of the country's inland waterways, the development of American marine insurance, and others, were discussed as necessarily bearing upon the general subject; while the fundamental and immediate necessity of building and maintaining enough ships to take care of the needs of the Allied and American armies in France, and at the same time to see that the needs of the rest of the world, as far as this country is concerned, are not neglected, were points brought out with vigor and clearness.

A telegram from E. N. Hurley, chairman of the United States Shipping Board, who was unable to be present in person, fittingly summarized the importance of shipping. After declaring that the place of America in the future is in the forefront of the world's commerce, he said:

American Ships in the World's Commerce

"We are building ships first and foremost for the war, but they will be useful for the future world trade as well. Remember that once their part in the winning of the war is ended a large number of them will be engaged in bringing back to home and industry the victorious soldiers, and in transporting to Europe the materials necessary for reconstruction of normal life, freed from the menace of avaricious autocracy. These vessels will serve the commerce of other nations equally with our own, their facilitations of the trade of the world will be the corollary of the freedom of the seas we fight to assure. And if there are any men among you who doubt that we are going to have a vast fleet, I will simply ask whether you have heard of a well-known man in our organization whose name is Charles M. Schwab."

A striking address on the subject of shipping, dealing with its important connection with the Pacific overseas trade and the present predominance of the Japanese there, as well as in the American coastwise trade, was delivered by Wm. D. Wheelwright, who said, in part:

"The extension of our trade depends primarily upon ships, but in only slightly less degree on the return cargoes, preferably of raw products, which must be had if ships are to run economically. Obviously, when a ship which carries our goods to Japan or China has to come back in ballast, the entire cost of the voyage must be borne by the outward cargo. This reduces the money value of our products to the extent of the extra freight, which at present shipping rates, unlikely to decrease materially for some time after the war, often determines whether we can afford to make a shipment.

"But there is another reason for our cultivating or originating a west-to-east business across the Pacific. We will be confronted at the conclusion of peace terms with the problem of the status of laborers, who have for years been employed on war work, and that of soldiers whose occupations will have gone. For the sake of the existence of our social order we must find remunerative employment for the great number of men who will soon after the war be seeking it. It is largely to handling and manufacture of raw products that we must look for employment of these men."

Pacific Shipping

"Under these conditions," Mr. Wheelwright continued, "the Japanese have come very near a monopoly of the carrying trade of the Pacific. They control not only established lines, which are supposed to carry freight for all shippers at fixed rates without discrimination (which they never do), but by tramp steamers, whose owners or charterers are also buyers and sellers of the cargo. One can hardly speak too highly of the energy and capacity of the Japanese, so you may ask yourself what chance an American has to compete with them in trade when he is dependent upon them for transportation!

"The United States Government will own enough ships to rehabilitate the ocean commerce of the country, if only the nation will continue its ownership and let the ships out to its citizens on fair terms. The sale of the ships would mean their immediate transfer to other flags, except as they could be used in coastwise trade, and would put an end forever to our hopes of a great maritime fleet operated under the Stars and Stripes. For, outside of coastwise trade, there would be no competition between foreign and American buyers, and the foreigners would get the fleet at their own price, and use it to perpetuate the exclusion of American citizens from the maritime trade of the world."

Growth of the Oil Fleet

Comment upon the enormous expansion of the petroleum industry since the war began, made by A. C. Bedford, chairman of the board of directors of the Standard Oil Company, of New Jersey, carried with it an explanation of the attendant increase in the size of the tanker fleet carrying oils abroad, and the gratifying news that still further expansion is going on. In this connection, Mr. Bedford said:

"We had amply provided for the needs of our trade abroad, but the first and unsurmountable obstacle has been our limited tank steamer mercantile marine, which has not been sufficient to transport war requirements and take care of these markets as well. There lies a problem that the war, both before and since America's entry into it, has brought out in sharp relief. In those faraway days, when there was no war, the exports of oil products were carried almost entirely in tankers of British, German, Dutch and Norwegian registry. America had very few

tank steamers flying the American flag. After the outbreak of the European conflict a number of German tank steamers were transferred to the American flag, and these to-day constitute an important part of the American fleet. A proportion of the British fleet of tank steamers was commandeered by the British Government to transport their requirements. The result was that it has not been possible to supply all the demands of the Allies and also the neutral nations."

Development of American Merchant Marine Necessary

"This situation constitutes a strong argument for the development of the American mercantile marine. Germany's relentless submarine warfare has emphasized this necessity, and the time has come when American shipowners must be given an opportunity of competing on equal terms with other nations, in the carrying trade. To the fulfillment of this ambition, dear to the heart of every American, the oil trade has already made some substantial contribution. On the outbreak of the war, orders for tankers were placed in large volume. The result is that while in 1914 the gross tanker tonnage flying the American flag amounted to 278,753 tons, the building programme has steadily expanded until at the present time our tanker tonnage amounts to 1,106,754 tons. The necessity of maintaining and upbuilding a merchant marine of this kind was recognized by the Shipping Board, with the result that still more tankers are being built, and we shall be better equipped than ever in the present year to fulfill all requirements for the prosecution of the war."

One address, that of M. E. Farr, president of the American Shipbuilding Company, of Cleveland, dealt wholly with the matter of shipbuilding, and should therefore be of special interest. It was brief, but very much to the point, dealing, as it did, with the essentials of the industry as it now stands. The address was as follows:

Essentials of the Shipbuilding Industry

"One of the greatest tasks confronting the world today is the replacing of ocean tonnage destroyed or incapacitated for use, through war operations. The sinkings of vessels by submarines do not represent the total destruction of deep-sea tonnage. The normal wear and tear, and the losses through collision, stranding and from other causes, incident to operation under war conditions, have greatly reduced the world's tonnage. All of this tonnage must be replaced by the shipbuilders of the world, principally by Great Britain, Japan and the United States.

"At the present time the energies of these countries are directed toward providing sufficient merchant tonnage to meet the war requirements and necessities of our Allies. That our part of the undertaking will be performed there is little doubt, and at the same time a solid foundation will be laid for the development and protection of our foreign trade. In order to accomplish this vast programme, the shipbuilder must have a free hand, unhampered by laws, restrictions and exacting requirements frequently imposed by Government agencies, and he must also have the earnest co-operation of the Government, labor, mills, and such manufacturers as are able to produce materials and equipment entering into the construction of steel and wooden vessels. Private enterprise and initiative in shipbuilding and shipowning should be encouraged and fostered by our Government.

"The urgent demand for ocean tonnage from foreign interests during the past two years led to the establishment of a large number of American shipyards, and the enlargement of existing concerns. This prepared the way for and gave stimulus to create greater capacity to produce ocean tonnage. Our entrance into the war further increased these activities. Three shipbuilding plants of large capacity are now in course of construction by the United States Shipping Board.

"All the available shipbuilding skill and talent has been assembled to carry out a vast program of ship production. Special tools and equipment, far beyond the capacity of American makers, were necessary, and were, therefore, not immediately available. On account of the limited supply of technical shipbuilders and skilled workmen and lack of equipment, nearly every new plant has been delayed in getting under way, and ship construction work in the plants of going concerns has been retarded on account of the loss of important men to the new enterprises.

"It is essential that shipbuilding plants be located where favorable weather conditions prevail, where the climate is equable and housing conditions are ample and good, and where an adequate supply of skilled, semi-skilled and common labor is obtainable. It is also important that such plants be situated on direct rail lines tapping fuel and material supplies, and in localities where economies in construction costs can be brought about.

Foreign Competition

"In order to compete with our foreign rivals after the present war is over, we must be able to produce ships equal in quality, cost and economy in operation, or lose in the race for maritime supremacy of quality. The American shipbuilders must, therefore, prepare for the strong competition by providing their plants with modern tools, machinery and equipment, and, what is still more important, by creating technical and operating organizations of the highest order and efficiency.

"Our leading post-war competitors will be Great Britain, Japan and Germany, although other countries will take an important part in ship production. The great potential resources in labor and material in countries not heretofore engaged in shipbuilding, may yet be developed, and these nations become powerful factors in ship production.

"The most reliable reports now obtainable show that the production of new tonnage overbalances that destroyed. A large amount of new American tonnage will soon be available, and production will rapidly increase in volume until an ocean-carrying capacity is provided fully ample to meet war and commercial requirements.

Comparison of Labor Costs

"Owing to high wages and the prevailing standard of living, construction costs in this country are excessive and compare unfavorably with conditions in Great Britain and Japan. The average daily wage for a nine-hour day in Great Britain and a ten-hour day in Japanese yards compare with the present wage for an eight-hour day in leading American yards, as follows:

	Great Britain, Dec. 1917.	Japan, 1917.	American.
Skilled	$2.16 to $2.79 (9/0 to 11/5)	75c to 90c (3/1½ to 3/9)	$5.80 (1/4/2)
Semi-skilled	$1.94 (8/1)	70c (2/11)	4.40 (18/4)
Unskilled	$1.81 (7/6½)	60c (2/6)	8.20 (18/4)

Piecework rates in American yards are proportionately higher.

"The standardization of ships has come to stay. This standardization may be applied to the conventional or the fabricated type. Variations in size and arrangement of steamers are necessary in order to meet the requirements of special trades and commodities, but in any event the

ship should be of standard design. Recent reports concerning concrete ship construction are encouraging, and it is hoped that this method of construction will stand the tests of service and become an important factor in our merchant marine.

"A committee consisting of representative shipbuilders, similar to the council associated with the British Admiralty, would be of great assistance to such of our Governmental agencies, as are concerned in the production of merchant ships.

"While the production of ocean tonnage may not have fully come up to the hopes and expectations of many, it must be remembered that the shipbuilding industry in America is in process of development, and the construction programme of the Navy and the shipping board is vastly greater than ever undertaken by any nation.

"Within the next few months the country will possess scores of shipyards, fully equipped for the production of both steel and wooden ships; mills with more than ample capacity to provide materials; and in sufficient skilled labor to enable us to continue a maximum of ship production. The unselfish co-operation of these interests is essential, if we are to successfully meet the certain competition of the future."

In view of the unanimous appreciation of the absolute necessity for fostering the merchant marine in every way possible, the adoption of certain clauses bearing on the subject, in a general declaration of principles presented for the approval of the convention by central convention committees, was not surprising; and these statements, embodying, as they do, the settled sense of such a large and influential body of American business men, promise well for the future of the American merchant marine, both in the improved position of the shipbuilding industry, in the minds of the public, and in the consequent hope for better treatment by the Government.

"The imperative need of the hour," ran these resolutions, in part, "is the presence in the North Atlantic of as great tonnage as can be handled in military transport without weakening the lines of supply of our forces which originate in all the non-European markets. Sacrifices necessary to this end will be gladly borne. The members of this convention, individually, and through the National Foreign Trade Council, stand ready to place at the Government's disposal their experience and information, to the end that the determination of the essential character of the various trades and the necessary curtailment of exports and imports shall be both practical and effective.

"A merchant marine is being created of tonnage sufficient, ultimately, to provide for the maintenance of necessary exports and import trade during the war, and for any reasonable expansion of that trade after the war, *provided that extra war costs of construction be readjusted to accord with the costs (with due allowance for depreciation) of the competing shipping of foreign nations after the war. Allowance also must be made for any extra costs of operation of these American steamers by reason of any handicap imposed by our shipping laws as compared with those of other nations.*"

Training Shipyard Workers by Emergency Fleet Corporation Methods

Carefully Selected Mechanics Taught by Skilled Instructors How to Impart Their Knowledge to Green Men—Production of Skilled Workers Imperative

BY R. V. RICKCORD

THERE can be no doubt that all but a negligible number of the men who know anything about shipbuilding are now engaged in the shipyards. The labor requirements for the country's shipbuilding programme are said to amount to a quarter of a million, in addition to those so engaged. It therefore goes without saying that the only means of building up this force is by training either green men or men who have allied trades. Because of the various methods which can be utilized in this undertaking, the shipbuilder has found himself in a somewhat puzzled situation. It has at least been necessary for him to experiment in order to find out the best method. As a separate consideration, there is, of course, the possibility of hiring ready-trained men from other yards; this aspect of the case, however, will not be discussed here, since the policy is so evidently a suicidal one that it is likely to be stopped by agreement between the shipbuilders themselves in co-operation with the Emergency Fleet Corporation. It is, on the other hand, quite obvious that every yard which is organized from now on must start with a nucleus of shipyard tradesmen, which cannot but come from other yards.

There has been no doubt concerning the desirability and importance of training men right in the yard, but on the question as to how this should be done the shipbuilders seem to be divided into two camps, the one holding the opinion that it is best to put the man right on the job, usually as a helper, and to depend upon the foreman or skilled worker to teach the learner the trade in addition to his doing regular work; and the other advocating that an instructor, either trained or untrained, be set aside, whose job it is to train the new man and to do nothing else—to regard his job as being not the production of the vessel, but the production of the skilled worker. The first method depends upon the good will of the foreman or the mechanic, and really makes him a philanthropist. The second method is the one advocated by the Industrial Training Department of the Emergency Fleet Corporation.

In developing emergency training methods for shipyards, the following facts were taken into consideration:

1. The only man who can teach a trade is the skilled mechanic who works at that trade.
2. The skilled mechanic is not usually a skilled instructor.
3. The skilled mechanic may be trained to become a skilled instructor.
4. Emergency training demands that the instructor be

skilled to give effective training in the least possible time.

It will be seen by examination of these four features that the instructor who is without training is at a disadvantage.

The turning of a shipyard tradesman into an instructor may look like a formidable undertaking; but, after having trained some three hundred and fifty men, the Industrial Training Department of the Emergency Fleet Corporation has not found this to be the case. It should be

A Typical Group of Shipyard Mechanics Learning to Be Instructors. From Ten to Twelve Men Are Handled by an Expert Trade Teacher.

recognized that it is impossible for the instructor to teach the new man anything, the distinction is rather that the new man must teach himself. If information can be given to the mechanic whereby he stimulates a desire within the new man to learn a trade and whereby the new man unconsciously teaches himself, a long step can be taken toward the making of a successful instructor.

The Emergency Fleet Corporation does not undertake to teach the various shipyard trades; the actual teaching of the trades can best be done in the yards where the men are needed. The suggestion has been made that all the men be trained in one place and supplied ready-made to the shipbuilders. This is equivalent to saying that all the ships required in the present programme be built in one yard. The real difficulty has been, not in obtaining men who knew enough about their trade to teach it *somehow or other,* but in equipping such men with information that will enable them to teach efficiently.

Under the arrangement made by the Industrial Training Department the shipyards seeking co-operation in the matter of training are expected to anticipate their future labor requirements and also to divide these needs over the various shipyard trades. Prospective instructors are chosen for the various trades; the choice of these men is left to the shipyards. The general qualifications for a prospective instructor are that he should at least be a sufficiently good mechanic to command the respect not only of the learner, but of other mechanics in the yard. Some of the best instructors have proved to be men with very little general education. The training period is six weeks, which may be spent either in an established center, like that at Newport News, or, if there are a sufficiently large number of instructors required in any one yard, arrangements may be made for placing an instruction center in that yard.

One of the first steps in the instruction process is that of teaching the artisan to divide up his trade into a series of steps so that like jobs in that trade are kept together and only samples of each type given to the new man. This locates every job in the trade and prevents any more repetition than is necessary in teaching. It also enables the trade to be laid out in a series of jobs progressively increasing in difficulty; this makes for a certain smoothness of instruction. What is not generally recognized by the shipbuilder is the fact that the art of instruction—"putting it over," or teaching the other fellow the trade—is an art by itself, and one usually requiring more study and a much more scientific approach than the learning of the shipyard trade itself.

Other subjects which are presented to the prospective instructor are the organization of a training department, the processes whereby a new man settles down to the job, the development of interest within the new man whereby he more easily learns what is given to him—in fact, the whole problem of instructing, holding and caring for the new man is more or less thoroughly considered as part of his training.

The tradesman at the training center for instructors is placed in a group numbering about twelve men; the instruction is given by an expert trade teacher, who may not necessarily be a shipbuilder. After the prospective instructor has studied the objective aspect of "putting over" the trade he gives a series of practical lessons. For this purpose a group of green men are supplied to him from the yard and he teaches his trade to these men under the stimulating influence of the shipyard workers in his group. This usually has the effect of inducing the man to be very careful what he says and does; he is often combative to an extent commensurate with the critical nature of his fellow-students. The result is wholesome for all concerned, and certainly not unfriendly.

Mr. Homer L. Ferguson, of Newport News, is to be thanked, not only for installing the industrial training center in the yard of the Newport News Shipbuilding &

The Expert Trade Teachers Are Loaned by Cities in Many States. Among the Cities Supplying Trade Instructors Are: Trenton and Newark, N. J.; Buffalo, Elmira and New York, N. Y.; Somerville, Quincy and Boston, Mass.; Seattle, Wash.

Dry Dock Company, and for extending his moldloft in order that it may be accommodated, but also for the supply of green men on the vessels when and where they are needed and for specific jobs in order that these men may be trained.

By the time the prospective instructor finishes his six weeks' training his viewpoint is changed from that of a tradesman whose idea is to progress with the job to that

of an instructor whose idea is to produce the tradesman from new material.

Against the putting of a new man with a trained instructor is the method, which has already been touched upon, of putting him with an experienced tradesman as a helper. The disadvantage of this lies in the fact that the new man is limited to the particular job or jobs the skilled man happens to be doing. In any case, there is usually no actual teaching, but rather a looking-on process.

If the new man is put with an instructor whose job it is to do nothing else but instruct, but who, nevertheless, is untrained, these disadvantages are still likely to occur.

Under the circumstances, the most efficient method of handling new men is probably through a specially organized training department, the work of which is independent of the production department. The training department should consist of a director and instructors, whose number will depend upon the requirements of the trades for which it is considered necessary to train men. The training department may be responsible to the general manager, superintendent or other executive officer, depending upon the yard organization. The steps in the employment and training of a new man should be as follows:

Original Group of Shipyard Mechanics Sent to Newport News Training Center for Instruction to Enable Them Most Efficiently to Teach the Various Shipyard Trades

Unless there has been a regular analysis of the trade, easy and difficult jobs are likely to be given promiscuously, the various operations shown rather than taught, and some uncertainty will exist as to whether the learner really knows the job; all this tends to lengthen out the period of instruction and to make it inefficient. In any case, there is usually very little attempt made to stimulate the learner to think for himself. No doubt the untrained instructor does exceedingly well sometimes, but the trained instructor is conscious of his aim, and is thus likely to be systematic in the turning out of his product—the skilled mechanic.

If the method of placing a green man with a foreman or with a tradesman for instruction is at all successful it means that a certain amount of the foreman's or the tradesman's time has been absorbed in the teaching process. This time should be given entirely to the production of ships. Much less time will be spent per man if an instructor is told off to do nothing but train, say ten, learners at a time.

1. Foreman sends requisition to employment department for a man in any one trade.
2. The new man is secured and sent to the foreman for his approval.
3. Foreman returns man to employment department with his approval.
4. The man is sent to the training department with the requisition that he be trained in the trade called for by the foreman.
5. The new man is placed under an instructor on the vessel. The foreman supplies the jobs specified by the instructor, but has nothing to do with the giving of instruction. The instructor trains the learner "on the job."
6. When the learner knows enough about the trade to be trusted alone, he is returned to the employment department.
7. The employment department sends the man to the foreman who originally sent in the requisition.
8. The foreman puts the man on the job.

Some of the largest yards in the country are employing

Training Center in Session, Showing Groups at Work

The building shown in the picture is an extension of the moldloft at the works of the Newport News Shipbuilding & Dry Dock Company, which was extended by Homer L. Ferguson, president of the company, to enable the Emergency Fleet Corporation to do the work of training shipyard trade instructors.

this method. For one of the large shipyards on the Atlantic coast no less than eighty instructors have been trained by the Industrial Training Department.

It would be well perhaps at this point to consider the limitations of evening schools as training centers for shipyard workers. In some localities very effective work is being done in these schools, particularly where the instructor is also the shipyard foreman or superintendent. This condition enables him to keep in contact with the learners, to see the difficulties the learner has to contend with, to discuss those difficulties during the evening class, and to see that they are removed during the next day. Good recruiting work is being done in a certain evening class in practical riveting. The class attracts men of other trades in the locality, who, if they prove sufficiently capable, are given an opportunity to learn the trade in the shipyard at good wages under trained instructors and actually on the vessel.

Evening-School Work Inefficient

But in spite of this, evening school work does not systematically, consecutively and efficiently *teach the trade*. The conditions are usually that equipment is lacking, the teaching period is short, the student is not in the best physical condition for absorbing the subject, and, after a day's work, the teacher is not primed to do his best.

Evening school instruction is nearly always in the nature of auxiliary information, useful hints about the trade, discussion as to how the job should be done, talks on the use of tools and material, the application of formulæ and tabulated information, but not usually actual practical experience in doing the job.

In considering the reasons why this information should rather be given while the job is actually being done in the yard or on the vessel, it should be remembered that evening school instruction is usually given to a group of men in a class-room, and that the individual members of a group are given the same information.

Why Instruction Should be Given "On the Job"

As likely as not these students will be in various stages of advancement in their trades even if, for class purposes, they are divided up into sections—elementary, intermediate and advanced. The instruction given, therefore, will not be of direct or immediate application, but rather is intended to be useful sometime in the near future, and a period will elapse before the learner needs to use it.

The disadvantage of this is twofold; first, the student is not so keenly interested as he would be if the information related directly to the job he happened to be doing; and secondly, he is likely to forget it because of the period of time which elapses.

In view of the difficulty of obtaining shipyard workers and the tendency of using men who have allied trades, the Industrial Training Department has also undertaken the work of training "conversion" men. Given a man with an "allied" trade, say, a structural iron-worker, of whom it is proposed to make an instructor in a shipyard trade, the scheme is to give him the regular instruction for an instructor and in addition as much actual experience in shipbuilding and information about the shipbuilding trade as will make him a man who can instruct in that trade. As an instructor of men who are from his old trade, he has the advantage of knowing the difficulties that these men have to contend with in learning the new trade.

Some of the wood shipbuilders are taking advantage of this scheme to convert good house-carpenter foremen into

(*Concluded on page* 361.)

Ferro-Concrete Ships*

Comprehensive Discussion of Materials and Systems of Construction—Plastered and Molded Ships—Weight, Cost and Durability

BY T. J. GUERITTE, ING. E. C. P.†

TO judge by the surprise evinced in the daily papers when the first reports were published a few months ago of the great impetus given by the war to ferro-concrete shipbuilding activities, one might have imagined that there was something startlingly new in the idea, and much nonsense was printed at the time, under big headlines. And still the last few years have merely seen the development of activities dating from many years back. It is, in fact, a curious coincidence that it was the author's privilege to deliver a paper entitled "Ferro-Concrete as applied to Floating Structures" in the year 1908, before one of the Newcastle building trades associations, the matter of which formed the basis of many of the articles which were published on the subject during the last few months. The conclusions of that paper ran as follows: "The particulars and illustrations given seem sufficient to indicate that ferro-concrete has to be taken into account as a shipbuilding material, owing to its small initial cost and the absence of upkeep. The author is far from thinking that super-dreadnoughts are likely to be built in ferro-concrete, at any rate for the present; but in smaller and commercial craft and for special purposes he is convinced that it will be used more and more. The question of weight is not so paramount as it may seem at first when to the weight of the hull is added that of all fittings and cargo, which remain the same, both for ferro-concrete and for steel ships." The recent strides made in this mode of construction seem to justify those prognostics.

So much has been written lately on the general principles and history of ferro-concrete as applied to shipbuilding that it seems unnecessary to recite once more these facts, and it is proposed therefore to enter at once into more precise details.

I.—Material of Construction

This is evidently a fundamental question, and we shall consider in turn the two components of a ferro-concrete hull, viz., concrete and steel.

(*a*) The concrete employed must be non-porous, so as to prevent leaking and the steel being attacked by sea water; it must also be strong so as to resist the heavy compressive stresses to which, in parts, it is submitted, and it should be as light as possible. The last-named condition is unfortunately difficult to fulfill at the same time as the other two, and the latter are of greater importance. Light aggregates such as pumice stone, ashes, coke, breeze, which are used in land work for making light concrete, are too porous; they would absorb a large weight of water and would give too weak a concrete; they cannot be utilized for ships. Clean shingle, of a flinty nature, is a suitable material, and would give a concrete slightly lighter in weight than crushed granite or whinstone. Gravel originating from sandstone must be subject to careful scrutiny before being allowed for ship construction, as it is sometimes of a somewhat porous and friable nature and might prove a source of weakness both as regards porosity and crushing strength. Crushed granite, and, generally speaking, crushed stone of a hard and impervious nature, are perhaps to be given the preference, notwithstanding their somewhat heavier weight. The same physical qualities are essential for the sand. Of the cement itself, little need be said; years of experience have proved that if it is up to British Standard Specification it will prove suitable for sea work.

With such constituents and it being understood that fresh water only should be used both for making the concrete and washing the aggregate if necessary, a suitable concrete will be made if proper proportions are adopted and the materials are properly mixed. In determining proportions great care should be taken that the aggregate be properly graded, that is, it should contain stones of various sizes, the smaller ones helping to fill the voids between the larger, and the same applies to the sand, which should be a mixture of sharp particles and of finer sand going down almost to dust. The proportions of voids both in the aggregate and in the sand should be carefully determined, and there should be a good excess of cement paste over the quantity strictly required to fill the voids of the sand, and similarly a good excess of mortar (*i. e.*, sand and cement paste) over that required to fill the voids in the aggregate. As previously mentioned, crushed stone will be used often as an aggregate, and it so happens that it contains, as a rule, a considerably greater proportion of voids than shingle, and this may result in porousness in the concrete unless proper attention is paid. The question of voids and of porousness is of very great importance, but forms in itself a vast subject. The author had the opportunity of reading a paper quite recently before the Society of Engineers on this subject, to which he would refer those interested; but it appears to him that its importance is such that it should be particularly emphasized to-night when dealing with concrete for ship construction.

From practical considerations the author does not deem it advisable to allow for a lesser thickness of concrete than 3 inches for the sides and bottom of a vessel, except in special circumstances, and however much one might like to see it reduced so as to lighten the structure. The figure of 2.8 inches is mentioned as a minimum in the preliminary rules for ferro-concrete ships issued by the Danish Government, but except for very small craft 3 inches will prove in practice to be the minimum. The scantlings of frames, strings, etc., are also reduced as much as possible owing to the same desire to reduce the weight, and the thickness may be taken at 2½ inches and even less in some cases, but great care will have to be exercised to insure proper covering of the bars by the concrete and and proper bond between them. It is, therefore, necessary to use an aggregate of small size, which will be worked easily in so restricted a space and among a comparatively great number of steel rods. Some engineers went as far as to suggest the total abandonment of aggregate, and the replacement of concrete by a mere sand and cement mortar. But the method has been proved to be unsatisfactory in ordinary ferro-concrete work, and the same would apply to ship construction. A happy medium is to be recommended, and the author's firm have ultimately adopted the following mixture for their designs:

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Aggregate, being a well-graded mixture of stones from ⅝ inch size down to ¼ inch, and free from sand, 27 cubic feet. Sand, from ⅛ inch downward, the grains being also of well-graded sizes, 13½ cubic feet. Cement, 8½ cwt. Such a concrete may be termed a 1.6:2:4 concrete. The above proportions apply as long as the percentage of voids in the aggregate does not exceed 50 percent. If it exceeds 50 percent a corresponding quantity of sand and cement is added. It has been suggested by various engineers that a much poorer concrete might be used with safety, say a 1:2:4 or 1.2:2:4 concrete, if a good rich rendering were applied later on the external surface of the sides and bottoms. But such a rendering would be extremely difficult to make properly, especially when nearing the bow and stern, and with the hard wear and tear to which ships are submitted it would soon come away in patches.

In order to obviate the difficulty of making a proper rendering, other engineers have suggested to use a comparatively poor concrete, say 1:2:4 or 1.2:2:4 for the inner 2 inches or 3 inches of the walls and bottom and to place carefully at the same time in the mold a rich mortar (1 of cement and 1 of sand) to form the external inch. The author's experience leads him to deprecate the juxtaposition of two concretes of so different a richness in cement, and unless supervision of the most constant and strict nature is exercised during the erection he doubts the efficacy of the method. All told, it seems decidedly better to adopt a uniformly rich mixture, such as mentioned above, which will give a very good face to the concrete when the molds are struck off, prove quite impervious, afford a high crushing strength, and be easily worked into the molds.

Steel

We turn now to the other component element of the structure, viz., the steel. The general tendency in ferro-concrete practice has been to utilize as reinforcing material mild steel in the form of ordinary round bars, with an ultimate tensile strength of from 28 tons to 32 tons per square inch, an elastic limit varying from 30,000 pounds to 40,000 pounds per square inch, and an elongation of at least 20 percent on a length of eight times the diameter. Such steel was used in the construction of most of the numerous river and canal barges and pontoons built in ferro-concrete during the last fifteen years, and it was natural to look to the same material again, when great impetus was given lately to the construction of sea craft in ferro-concrete by the difficulty of procuring all the steel plates required for commercial craft. Mild steel was therefore used and will be used in many ships notwithstanding the difficulty one meets in obtaining it at present. Shell discard steel has been put forward as a substitute, mostly with the object of avoiding the use of mild steel, seeing that it is more easily obtainable than the latter at present, but not owing to its special physical properties. For the present, apparently, Lloyd's Register are not prepared to sanction its use. One of their surveyors, Mr. Bernard J. Ives, has stated that, "As the ferro-concrete ship is only in its experimental stage and as practically no experience has been obtained so far from actual seagoing conditions, a wise precaution at the present time is to eliminate any doubtful factors, and the steel should therefore be of the quality used in ordinary shipbuilding work."

It is a question, however, whether the disadvantages attaching to the use of shell discard steel, if one looks at the question from the usual standpoint of steel ship construction, would not be more than compensated by certain advantages it would present from a ferro-concrete point of view. These advantages are somewhat similar to those attaching to the use of a special quality of steel, which the author's firm, after careful consideration of the matter during the last two years, are now specifying for ferro-concrete ship construction. It may be stated at the outset that the problems of ferro-concrete construction as applied to naval architecture are very different from its problems as applied to land work. Firstly, and for obvious reasons, it is desirable to reduce the weight of the hull, and consequently of all the scantlings as much as ever possible, consistent with good work. It becomes, therefore, of great interest to use for the reinforcement steel possessing a higher elastic limit than mild steel, the elastic limit being an all-important factor in ferro-concrete work. Not only does this obviously tend to reduce the weight of steel required, and consequently the weight of the hull, but also the same cover of concrete over the reinforcing rods can be maintained while reducing the thickness of the members by the same amount as the diameters of the high elastic limit steel rods are smaller than those of the mild steel bars which would otherwise be used, thus securing an indirect but very important saving in the weight of the hull.

A second point which deserves very careful consideration is that of the transmission of the stresses in the steel from bar to bar. As is well known, in ferro-concrete construction the bars are not tied together, nor welded, nor connected by coupling boxes (except in very special circumstances). Stresses are transmitted from bar to bar through the agency of the adhesion grip of the concrete surrounding them, the bars overlapping each other. Their ends are usually fishtailed or hooked, with a view to helping further the adhesion. In ordinary ferro-concrete work the mass of concrete surrounding the rods is comparatively large, and there is ample room for overlapping of the rods and for the hooks or fishtails, so that most of the experts in ferro-concrete consider it quite unnecessary to use bars with mechanical bond. In ship construction, as has been previously stated, scantlings are reduced to a minimum, and the bars being very much closer together real difficulty is experienced in finding room for overlaps of the length required if ordinary round rods are used, and also for hooks, especially in longitudinal members. The problem is serious, and experiments carried out in France last year upon a river barge of 400 tons deadweight, which was purposely tested until rupture under load in dry dock, proved the ultimate failure to be due to the slipping of the longitudinal rods, consequent upon the insufficiency of overlapping. It must be added that the overlaps were in fact considerably shorter than sound design would have required. But the indication given must not be neglected. It therefore becomes useful for ferro-concrete ship construction to adopt bars which present a greater adhesive power than ordinary round bars. Tests have proved that certain bars are obtainable which have a grip of 60 percent greater than that of ordinary rounds; their use will obviously reduce the amount of overlapping otherwise required. But such greater adhesion should not be obtained by the addition of sharp projections or ribs on the bars which might have a tendency to be the starting point of minute cracks in the concrete, and which, in addition, are useless from the point of view of the main stresses. In other words, the bond should be continuous, and should not entail an additional weight of steel. To sum up the question of the steel, the author has found the nearest approach of what he considers the ideal steel reinforcement for shipbuilding work in bars manufactured

from mild steel in accordance with British Standard Specification for structural steel, but which, owing to their special shape and the physical treatment they receive after rolling, acquire an elastic limit of over 50,000 pounds per square inch, present a satisfactory and continuous bond without sharp indentations or projections, and remain capable of cold bending round a bar of 1½ times their diameter without injury.

Shell discard steel, if of a somewhat unequal quality, possesses at least one of the desiderata, viz., high elastic limit. Dangerous as may be its use in the shape of girders or, more generally, structural steelwork, where stresses may be said to be extremely localized, it is felt that its use in the shape of numerous rods of small diameter scattered throughout the mass of a ferro-concrete structure does not present the same danger. It seems, therefore, that the question of its employment might be left open for further consideration, and the experience gained from the behavior of the numerous ferro-concrete works in which it was used since 1915 will be of great help in that direction.

II.—Systems of Construction

Having examined the constituting materials, one may now attempt to reply to the query: "What are the various systems of construction?" They seem to fall under two headings—Plastered ships; molded ships.

Plastered Ships

The first cost of a mold in which to cast a ferro-concrete ship, in a similar way as is generally done for ordinary ferro-concrete work, is high, and it was natural that one should attempt to avoid using one. Many of the numerous river barges and pontoons built in Italy since 1902 consisted mostly of a steel mesh work set to shape and plastered on both sides with cement mortar, very much as a ceiling of a room plastered on a metallic lathing. Italians are very clever cement plasterers, and the method proved successful for small craft which are never strained heavily. Small motor boats or canoes have been built similarly in various countries, including of course, the small pioneer rowing boat built in France in 1849 by Lamjot, and which has now become historical.

When one comes, however, to heavier craft, and particularly seagoing craft, mesh work is found to be not practical for the arrangement of the main steel reinforcement; the number of skilled plasterers able to do justice to such difficult work is very small at present; and what is more important, plaster work of that kind does not give a concrete sufficiently strong to meet the stresses imposed upon it. The claims of the "cement gun" in that respect do not appear as yet to be justified. The author is convinced that for all vessels of large size the plastering method has to give way to the method of molding and casting, and he is under the impression that it will not be sanctioned by at least one of the Registry Societies, in view of experience lately acquired in that direction.

Molded Ships

(1) In the first place, there should be a warning against the practice recommended by one or two American contractors of building a sort of rigid metallic work—lattice girders forming the skeleton of all the frames, and also the skeleton of the sides, and encasing this metallic framework in concrete. The advantages claimed are simplicity and quickness of construction. It must be stated that analogous practice prevailed among a few designers in the early days of reinforced concrete construction, but it was gradually discarded in favor of the more scientific and efficient designs which have been in universal use for the last twenty years, the principle of which is that the reinforcement is not a rigid frame by itself.

The author considers that there would be no appreciable saving in time, and there are very serious defects inherent to the system. All ferro-concrete experts agree that the ideal design in ferro-concrete is that in which the reinforcing rods are individually as small as possible and as numerous as is practicable, so that the stresses be distributed to the extreme possible limit throughout the mass of ferro-concrete. The result is best attained by the use of small rods and links. It has been very properly stated by the most eminent authorities on ferro-concrete that it is a new material and not a mere juxtaposition of concrete and steel; it has, in fact, qualities and idiosyncrasies of its own quite distinct from those of its constituent elements. If, however, the steel is concentrated in parts of the mass instead of being distributed throughout, the work thus obtained loses those peculiarities just referred to; the concrete will not lend its properties to the steel and borrow some from the latter in so complete a manner, and *vice versa*. In particular, the large cracks so characteristic of ordinary concrete work, and unknown in ferro-concrete, would tend to appear, and this would be a very serious defect in ships. The work would also lose the resilience and elasticity which is so striking a character of ferro-concrete.

Another point is that a rigid framework of that kind, instead of being made of round bars, would require flat bars and small angles; in fact, structural steelwork of the very kind that is most in demand to-day. It would also require the employment of steel workers of the very kind one wishes at the present time not to draw upon, seeing that all the steel work would have to be punched, bolted and riveted. Moreover, experience has shown that such a method of reinforcement is more wasteful in steel by 15 percent to 20 percent. It has also been found in practice that in reinforced concrete work it is most advisable to avoid any sharp angles or corners in the steelwork, all such angles being potential starting points of cracks; and that concrete adheres less easily to comparatively large and flat surfaces such as presented by angle bars than to ordinary round bars. It may also be added that if, in order to avoid riveting, an attempt is made to use bolts, as the bolt holes will be greater diameter than the holes (so as to facilitate fitting up) there will remain throughout the framework an immense number of small recesses to which concrete will not have access; the steel work will therefore not receive in those points the protection against corrosion which the concrete should afford it, and such points will be potential starting points of corrosion. For all those reasons, tempting as the idea may be at first to those not thoroughly accustomed to reinforced concrete work, rigid framing has to give way to the usual non-rigid round bar skeleton reinforcement.

(2) The Norwegian method of casting the boats upside down, launching them in that position, and letting the hull right itself in the water, has been profusely described and illustrated in the daily papers and magazines. The reason for that unusual procedure is stated to be a desire to avoid the use of double shuttering. But, as far as the deck and bottom are concerned, there is no more need for a double shuttering in the usual method than in the upside-down one, and as regards the sides there is as much need for it in one as in the other. It seems that the upside-down method has been used for very small vessels, 200 tons deadweight, but it is doubtful whether it is workable in the case of bigger craft, say 1,000-ton or 2,000-ton boats, and the author is at a loss to see any advantages in it.

(3) In the construction of river barges in France, the desire to reduce the cost of shuttering has led to certain constructors experimenting with pre-cast wall plates of the required dimensions to fill the rectangular spaces between frames and stringers. The frames and stringers are cast *in situ*, and the wall plates set in position between them so as to be incorporated into the structure during their concreting, the bond being given by the ends of the reinforcing bars of the plates, which protrude all round. Although the results were said to be satisfactory (at first in any case) it is interesting to note that when the same contractors built larger river craft (600 tons and 1,000 tons deadweight) they abandoned the slab principle and reverted to casting *in situ*. For seagoing craft, which are submitted to hogging and sagging stresses, the author feels that the slabs would work loose, and further, the steel used in their construction, and which is in short lengths, would not be utilized for meeting the general stresses in such an efficient manner as it can be when the plates are monolithic with the frames and stringers. This mode of construction is therefore to be deprecated.

(4) Another "system" is that in which timber molds are dispensed with for the walls by using two sheets of metal lathing between which the concrete is poured. Some of it works through the mesh and forms knobs upon the two outer surfaces, which knobs in turn form anchorage for plastering coats added later on. The objection against the use of plastering coats required to finish the surface has been stated before. Another drawback of this method is the concrete poured between two resilient sheets of meshing cannot be rammed or punned properly, and, in consequence, it is impossible to obtain a good, strong and impervious concrete. The advocates of this method, in fact, are said to recommend the addition of a waterproof coating, which the author has no doubt would indeed prove very necessary with such a method.

(5) Reverting now to the normal and usual method of construction, it can hardly be divided into systems. A few patents have been taken in the matter, but they mostly bear on questions of detail; the general principles underlying all the designs are the same, and it is merely the experience and skill of the designers which may differentiate the various types adopted. In that respect the author is fully in accord with the remarks made by Mr. A. T. Wall in the *Engineering Supplement* of *The Times* regarding the absolute necessity for close co-operation in the design of ships between naval architects and ferro-concrete experts. The latter, or at any rate the broad-minded ones among them, fully recognize that the science of naval architecture and the practical experience which is necessary when applying its principles, require years to be acquired; and in the same way the extremely complex problems of ferro-concrete design as applied to naval architecture can only be solved by the application of years of experience. Excellent results will be the fruit of close co-operation, and the attempt to work independently of each other has already resulted in a number of failures, and will continue to do so.

Having thus reviewed the material and the method of construction of ferro-concrete ships, it is now necessary to inquire into the claims put forward by the advocates of such ships, and see whether they can be substantiated.

Speed of Construction

One of these claims is a great speed of construction. It must be borne in mind that up to the time of writing the biggest units launched are barges of 1,000 tons deadweight. For bigger tonnage no actual facts can be mentioned, but by inference experts may gage pretty accurately the time required.

In the construction of a large number of 250 horsepower tugs now being built in France, the author was able to satisfy himself that two weeks were sufficient to erect the molds (for repeat tugs; the erection of the first mold took somewhat longer) and place the steel in position. The process of concreting was occasionally carried out in 48 hours. All told, it is safe to say that in normal working the yard referred to completes a hull in three weeks. The tugs take water broadside on, and an average of three weeks is allowed for maturing. With the restricted amount of labor at present available, the said yard can turn out one of these tugs every week, but from explanations given to the author by the yard's manager it is certain that two tugs could be completed every week in normal times.

In another place the author has seen in what was four months before a bare field, two 1,000 ton deadweight barges ready for launching, and several others following closely. Barges of that kind, or again, the hulls of small cargo steamers of 1,000 tons deadweight, may easily be turned out and launched at the rate of one every ten weeks from each slip in a well-organized yard. For obvious reasons it is impossible at the present time to give precise figures as to the actual speed of construction of bigger ferro-concrete craft. However, having discussed the programmes of construction both with British and with French contractors, the author considers that in regular working order the completion of the hull of 1,000 tons deadweight cargoes would take about 1½ months from start to finish. That of 2,000 tons 2 months. A 3,000 tons cargo would require 2¾ months, and a 5,000 tons about 4½ months.

The time required for the fitting of machinery, etc., would be practically identical for such ships and for steel ships, so that from the above figures the total time required to complete the ship may be deduced. It will be understood that from 3 to 5 weeks has to be added to allow for the maturing of the concrete. In ordinary land work one considers generally that a test load may be imposed upon a new floor 5 or 6 weeks after its completion. But the concrete used in that case is not so rich in cement as for ships, and the richer the concrete the quicker the required strength is attained. It might be possible to utilize that period for partly fitting up the ship instead of waiting until she is afloat, so that the maturing period would not be lost altogether.

Ease and Speed of Repairs

This question of speed in construction leads us to another important consideration, viz., the ease and speed with which ferro-concrete ships may be repaired. Ferro-concrete has been proved to withstand damage to a remarkable extent. One need only refer briefly to its excellent behavior during the earthquakes, during subsidence of foundations, etc. This is due to the monolithic character of the work and its great cohesion.

The following example will give a clear idea of the possibilities of ferro-concrete in that respect. In 1909, a monolithic building was erected from Messrs. Mouchel & Partners' designs at Northwich, a district famous for appalling subsidences due to the extraction of brine from the lower strata. The building, boxlike fashion, rested on 20 foundation piers, but without connection with them, and it was arranged that the piers should be kept under observation, so that if any showed signs of subsidence packing should be inserted and the building jacked up. In December, 1915, signs of subsidence were detected, and a joint inspection was made by the Surveyor of the Northwich Salt Compensation Board and the author, when the almost incredible fact was revealed

that out of the 20 piers 12 had subsided and parted with the superstructure, the latter remaining supported on eight piers only. Enormous strains must have developed in the portions of the building thus transformed into big cantilevers, but the report stated that "thorough inspection of the whole building, with special attention to mainbeams, secondary beams and ceilings failed to reveal any trace of weakness or strain." Such is the resiliency, the power of accommodation to new circumstances, of ferro-concrete.

Again, in 1907 an 8,000-ton steamer crashed into a ferro-concrete jetty in the river Thames. The engineer, Mr. C. S. Meik, M. Inst. C. E., stated at the time that if the jetty had been a timber one the steamer must have gone right through it. As it was, the only damage was the destruction of a few piles and about 20 square feet of decking.

It must be understood that damage to ferro-concrete work is always of a most localized nature. At the time of the great explosion at Silvertown in January, 1917, a steel girder weighing nearly one ton was blown up and fell headlong upon a ferro-concrete wharf some 50 yards away. It went through a panel of the decking, but the hole made was hardly more than 1 foot by 2 feet, the adjoining beams not suffering in the slightest; the damage was therefore insignificant and most easily repaired.

This localization of damage, which is extremely important in ship construction, is borne out by observation of the effects of shell fire on ferro-concrete. On the western front a ferro-concrete water tower 52 feet high formed for a long time a convenient observation post for the Germans and a prominent target for our guns. When in March, 1917, the Germans proceeded with their so-called "victorious retirement," they took good care to bring down the tower by dynamiting its legs, the tank proper falling from its full height to the ground. But according to written statements, the shells which had struck the tank merely made circular holes through the sides and bottom, and the fall to the ground caused only local cracks. After small repairs, the tank could be used either on the ground or jacked up gradually to its original position.

Such local damage as may occur in ferro-concrete ships will be most easily repaired, the hole being blocked up by providing a small timber shuttering and filling the hole with new concrete, after having added, if need be a few strengthening bars. By using a very rich mixture of concrete, the patch will be able to stand the water pressure in a couple of days or even less, and if need be, one may not remove the shuttering before putting to sea again, for further safety. Such a repair may even be carried out under water. Cementing or concreting repairs to quay walls or jetties under water are by no means processes unknown to civil engineers.

In December last the author had the good fortune (if he may put it that way) to inspect a 1,000-ton barge which a couple of days previously had suffered damage during a faulty launching; it had been repaired as explained above, and was then afloat and in excellent condition. Several instances of damage to river or canal barges in use abroad have been recorded, pointing all to the same conclusion, and all investigators seem agreed that repairs to ferro-concrete ships will be quicker and much cheaper than to steel vessels. Alterations to the design in course of erection, or while the ship is in service, are quite easy. The author has witnessed in France a fairly sweeping alteration in the position and arrangement of hatchways and companions in a vessel nearing completion, which confirms this statement.

Lasting Qualities of Ferro-Concrete Vessels

Views on that aspect of the question are difficult to express, for the reason that experience has not yet been obtained regarding their behavior at sea over long periods. Most probably steel shipbuilders found themselves in the same predicament when steel was first put forward as a substitute for timber. Let us also proceed by inference. We know that ferro-concrete on land is a most permanent material, requiring no upkeep, no painting, and increasing in strength with age. We know that the same applies to ferro-concrete seat work or tidal work, jetties, quays, etc., when properly designed and carried out. There may have been a few cases (very few indeed in proportion to the number of successful works) in which defects developed. But in those cases the defect can always be traced to causes which do not affect the principle of ferro-concrete, and could have been avoided by taking due care. The author has read practically every attack made upon ferro-concrete and its lasting properties, but up to the present he has not seen one that was vital. Local examples being always of special interest, one may properly refer here to a ferro-concrete jetty built in 1901 at the C. W. S. works, Dunston-on-Tyne, with a rise and fall of tide of 15 feet, and which is in absolutely perfect condition, although it is now submitted to much greater shocks than was anticipated owing to the increased tonnage of vessels accommodated.

We know, further, that ferro-concrete vessels for river or canal or harbor work have stood the test of time very well indeed; comprehensive lists of such vessels have been printed so often lately that it is unnecessary to repeat them.

On the other hand, we know that seacraft are submitted to much more severe strains, and this is where doubt may arise. To overcome the difficulties which confront ferro-concrete seacraft, one must first of all realize them fully, and recognize the inherent drawbacks of the material. It is then comparatively easy to devise means for removing the disabilities. That there will be failures cannot be doubted. Most of them will arise from imperfect understanding of the effect of combined stresses. But the experience already at our disposal is sufficient to show that some of the difficulties encountered can be overcome by more careful designing, and there are good grounds for assuming that the ferro-concrete vessels which it is now proposed to build up to a certain size will have the necessary lasting qualities. The question now arises as to what is the limiting size of ferro-concrete ships, but before trying to give a tentative reply to the query it is necessary to face one of the great defects of ferro-concrete vessels, viz., their weight.

Weight of Ferro-Concrete Vessels

It is so obvious that ferro-concrete vessels are heavier than steel ones that there is no need to explain why. The important point is to make a comparison between vessels of the two classes and of same deadweight carrying capacity. The designs of vessels upwards of 1,000 tons deadweight prepared by the author's firm comprise one deck single-screw cargo vessels of 1,000 tons, 2,000 tons, 4,000 tons and 6,000 tons deadweight, and the comparison will be limited to those. It must be stated that the full detailed working plans for the larger units are not quite completed as yet, so that slight alterations in the figures here below given are possible.

In the following tables the figures referring to the steel vessels have been kindly prepared by Mr. R. Cole and Mr. H. Burgess, of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, also the design of the

ferro-concrete vessels has been prepared in collaboration with Mr. T. G. Owens Thurston, of Messrs. Vickers, Limited and to them the author wishes to tender here his best thanks.

The annexed Table I allows one to compare at a glance the main characteristics of the vessels. From the figures in that table another, Table II, has been prepared, which gives the factor for converting deadweight carrying capacity into total displacement, both for the steel and the ferro-concrete vessels figuring in Table I.

One can see that the disadvantages attaching to ferro-concrete vessels in the matter of weight are greater in the case of small tonnage; although ferro-concrete vessels cannot hope to become as light as steel vessels even for big tonnage, the disadvantage becomes less and less marked when the size grows. This is due to the fact that the minimum thickness of concrete which is necessary for practical reasons, even for small units, need not be increased at the same rate when tonnage grows bigger. Where 3 inches are necessary for a 1,000 tons cargo, a 2,000 tons requires hardly 4 inches.

TABLE I.—ONE-DECK, SINGLE-SCREW CARGO STEAMERS

Deadweight All Told in Tons.	1,000		2,000		4,000		6,000	
	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.	Steel.	Ferro-Concrete.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Length between perpendiculars	180 0	210 0	220 0	245 0	285 0	305 0	340 0	355 0
Breadth molded	29 0	33 6	35 0	38 9	41 6	44 3	45 9	48 0
Depth molded to upper deck	16 6	16 9	20 0	20 3	25 0	25 3	28 3	28 6
Mean draft	14 9	14 9	17 9	17 9	21 3	21 3	23 3	23 3
Displacement in tons	1,600	2,225	2,910	3,660	5,550	6,465	8,240	9,210

TABLE II.—FACTORS FOR CONVERSION OF DEADWEIGHT CARRYING CAPACITY INTO TOTAL DISPLACEMENT

Deadweight All Told in Tons.	1,000	2,000	4,000	6,000
Steel vessels	1.600	1.455	1.387	1.373
Ferro-concrete vessels	2.225	1.830	1.616	1.535

TABLE III.—EXCESS DISPLACEMENT OF FERRO-CONCRETE VESSELS OVER STEEL VESSELS OF SAME DEADWEIGHT CARRYING CAPACITY

Deadweight All Told in Tons.	1,000	2,000	4,000	6,000
Excess percent	39	25.8	16.5	11.8

For a 1,000 ton deadweight steamer the displacement of the ferro-concrete vessel exceeds that of the steel vessel by as much as 39 percent; for 2,000 tons deadweight the excess is only 30 percent; for 4,000-tons deadweight, 18 percent; and for 6,000 tons deadweight under 15 percent. It seems probable that for vessels over 6,000 tons the excess may be lowered further still, very slightly, say to 14 percent or 13 percent, but that would seem to be the limit, at any rate, until new developments take place in ferro-concrete naval architecture. But even as the case now stands, one might be tempted to say that the consideration of weight would not place any upward limit to the size to which ferro-concrete vessels may be built. There is, however, another important consideration which comes into play, viz., that of comparative cost, which has now to be inquired into.

Cost of Ferro-Concrete Ships

The saving which can be effected by ferro-concrete in a certain class of vessel is due partly to the saving in steel, partly to the fact that no heavy plant is required for ferro-concrete work, and partly to the fact that the bulk of the labor employed need not be skilled, and is therefore cheaper. But if the last two factors remain the same whatever the size of the vessel, the first is a variable one. To start with it must be stated that the saving in steel is not as great as was wildly claimed at first by superficial designers who had not grasped the difficulties of the problem; a saving of 80 percent, or even more, as has been mentioned occasionally, seems quite out of the question. Nevertheless the saving exists, and in some cases exceeds 50 percent, or 55 percent, which is not at all negligible. And in that respect it is as well when comparing figures to note that in ferro-concrete there is no waste of steel in the process of construction, whereas it seems a recognized fact the weight of steel required for building a steel ship is about 10 percent greater than that of the steel which is finally embodied in the structure owing to waste in cuts of plates, angles, rivet holes, etc. As far as stresses go steel is not used very economically for steel ships of small tonnage, but it receives a better utilization when the tonnage grows. By way of illustration, taking as units the stresses per square inch on the upper deck and on the bottom plating respectively for steel cargo vessels of 1,000 tons deadweight, it may be assumed that the stresses in bigger vessels would approximately be greater in the ratio shown in the following Table IV:

TABLE IV.—RATIO OF INCREASE OF STRESS TONS PER SQUARE INCH

Deadweight in Tons.	1,000	2,000	3,000	4,000	5,000	6,000
On upper deck	1	1.18	1.33	1.44	1.54	1.64
Bottom plating	1	1.22	1.40	1.58	1.75	1.94

It will be seen that steel vessels have to meet the same difficulty as ferro-concrete vessels in the case of small tonnage, viz., a bad utilization of the full strength of the constituent materials. Whereas, however, in the case of ferro-concrete it is the concrete which is badly utilized (as far as its potential strength is concerned), in steel vessels it is the steel. In both cases the drawback gradually disappears when the tonnage increases.

A much better utilization of the steel takes place in ferro-concrete ships of small tonnage, utilization which cannot be improved upon very much when tonnage increases. It would seem that the important saving in steel resulting from the adoption of ferro-concrete for ships of small tonnage remains a fairly constant percentage up to, say, 3,000 tons deadweight, but in the light of present designing that for larger units it would become gradually smaller.

It is most difficult to give an accurate comparison of the prices for steel and ferro-concrete ships. The question is so beclouded by considerations of many kinds that it has been questioned whether the undeniable advantage which ferro-concrete offers to-day in this respect will remain when normal times return. The author feels unable to give precise indications which actual experience may alone procure. But it seems fair to say that on a pre-war basis one may estimate that the cost of the ferro-concrete hull is about 70 percent of the cost of the steel hull of same deadweight carrying capacity in the case of small tonnage, the saving becoming somewhat less important for bigger units. As against this one may set up the fact that the cost of machinery and outfit for concrete vessels is, approximately, 5 percent dearer than it is for steel vessels.

In conclusion, the author wishes to apologize for the limitations of the paper and its shortcomings, of which none is more aware than himself.

A System for the Design of Ships with Straight-Lined Sections

Simplicity of Calculations, Laying Off and Construction the Key-note of New Method Proposed for Designing Straight Line Ships

BY C. W. BION

THE writer would like to pass a few general remarks on ship forms and their relations to resistance, especially as the system to be described is largely dependent on them.

The two curves which govern the form of any vessel are the curves of transverse sectional areas and the load water plane. Sir Phillip Watts once said that the principal feature which governs the resistance of a ship is the longitudinal disposition of its volume. Once, therefore, having fixed the areas curve, the next important factor which comes into play is the load water plane, for it is

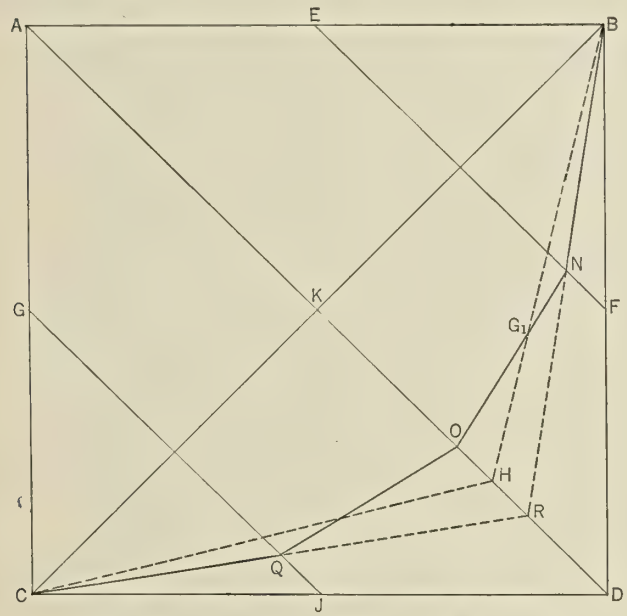


Fig. 1.—Construction for Transverse Section

obvious that this curve at once governs the vertical distribution of volume. In other words, the load waterline curve, together with the areas curve, will give the coefficient of fineness of each transverse section in the ship—i. e., the vertical disposition of volume.

In passing, it may be remarked that the shape of the curve of coefficients of fineness of sections, especially that of the after body, is of some importance and interest with regard to resistance, especially at high speeds. Admiral Taylor has conducted experiments bearing on the above point.

Passing now to the shape of the transverse sections of ships, which is really the subject of this article, it will be conceded that they are generally of parabolic form. Admiral Taylor has shown them to be parabolic for fine coefficients and hyperbolic for full coefficients. The writer has made some investigations in this matter and finds that they can be represented by parabolas described generally by the figure used in connection with Morrish's formula for the vertical position of the center of buoyancy. Sections which are wholly convex or concave outward give the best results, especially in the full size ship, as they insure the easiest motion in a sea way. Very concave convex sections aft are rather liable to cause thumping action at sea and therefore reduction of efficiency. Thus in the series given below a section aft of .500 coefficient is described by a straight line.

To obtain a series of straight-line transverse sections Morrish's figure was taken as a basis and modified as follows. Fig. 1 shows the construction of one of these sections comprised of four straight lines. The point to be

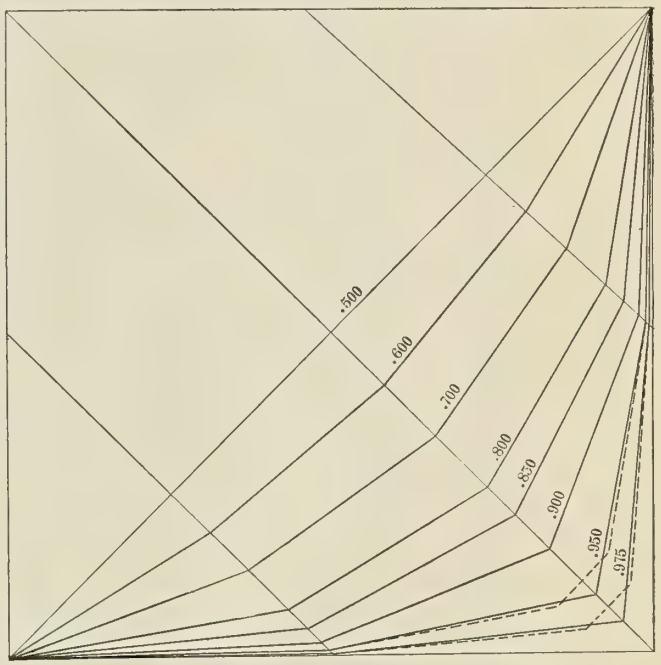


Fig. 2.—Series of Transverse Sections

observed was that these figures must be such that *BR* and *RC*, which may be considered as the tangents at load waterline and keel, must never lie outside the enclosing rectangle. This was obtained by following parabolic forms whose tangents at *B* and *C* always lay within *BD* and *CD*. The point *O* was then found so that *BR* lay within *BD*. To obtain *BR*, set off *HR* equal to *HO* on the diagonal *AD*, *H* being the intersection of the Morrish figure on the diagonal. Now as coefficients increase, *Q* and *R* will converge towards *H*; that is to say, if all such lengths as *KR* were plotted to a base of coefficient of fineness the first differential of this curve would never be zero before *KR* equaled *KD* or when the coefficient of section equaled 1.000.

In the series given, the first differential is zero at the point when $KR = KD$. To obtain the points *N* and *Q*, draw *EF* and *GJ* parallel to *AD* and cutting *AB*, *BD* and *AC*, *CD* at half their lengths. The intersections of *BR* and *EF* and *RC* and *GJ* will give the points *N* and *Q*. The figure *ABNOQC* equals *ABHC* in area and approximates to a parabola since *NO* and *OQ* cut *BH* and *CH* at one-third their lengths from *H*. To describe any one of these

DESIGN OF SHIPS WITH STRAIGHT-LINED SECTIONS

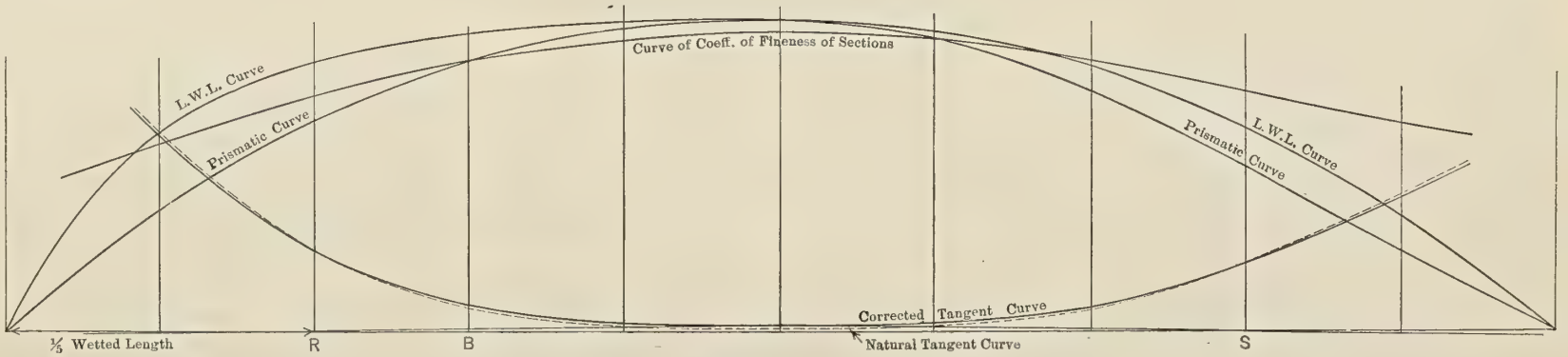


Fig. 3.—Waterline and Area Curves

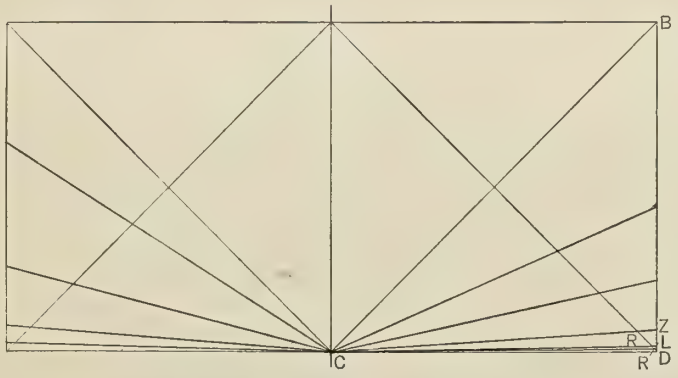


Fig. 4.—Showing Natural Tangents

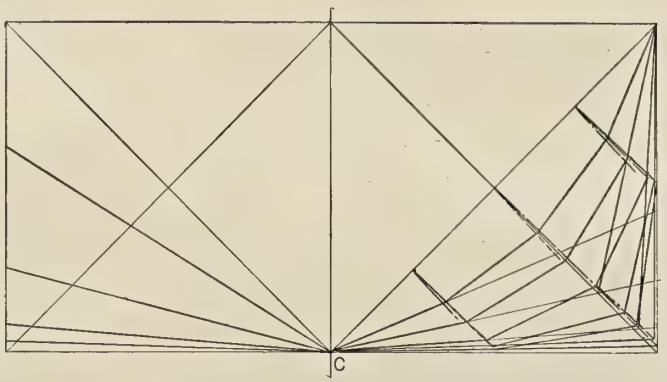


Fig. 5.—Showing Corrected Tangents and Sections in Fore Body

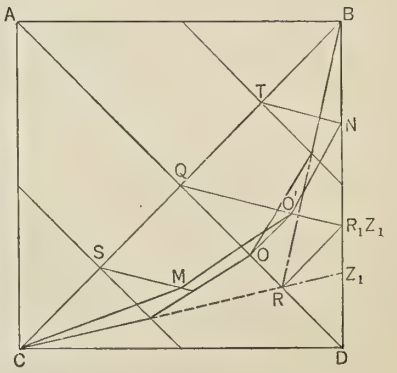


Fig. 6

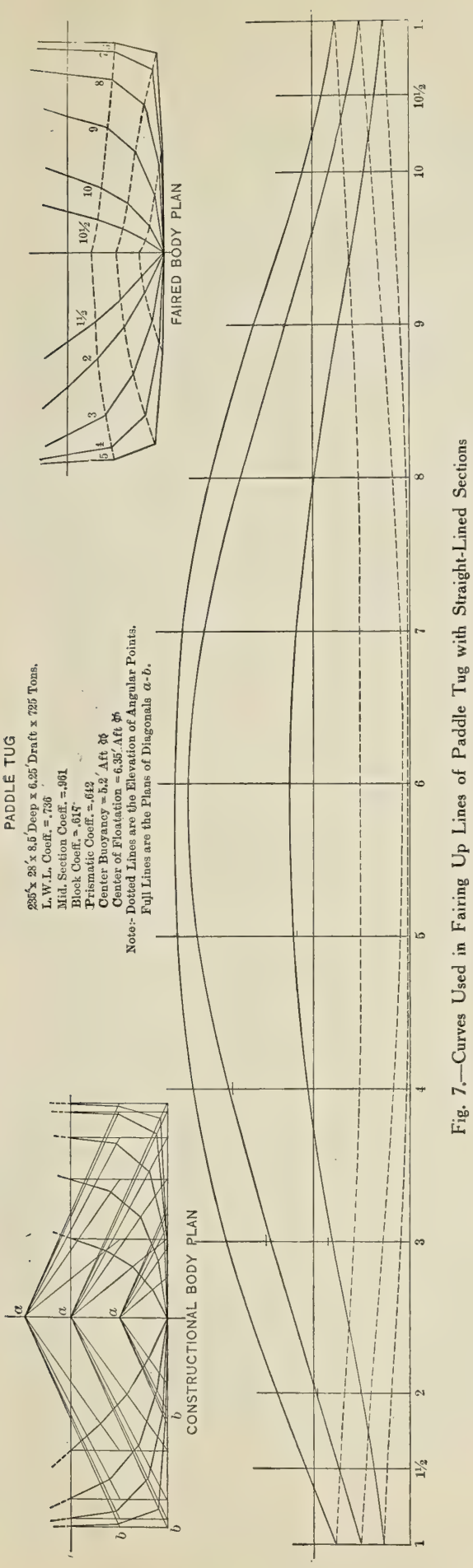

PADDLE TUG
235' x 28' x 8.5' Deep x 6.25' Draft x 725 Tons.
L.W.L. Coeff. = .736
Mid. Section Coeff. = .961
Block Coeff. = .615
Prismatic Coeff. = .642
Center Buoyancy = 5.2' Aft ℄
Center of Floatation = 6.35' Aft ℄
Note:- Dotted Lines are the Elevation of Angular Points.
Full Lines are the Plans of Diagonals a-b.
FAIRED BODY PLAN
CONSTRUCTIONAL BODY PLAN

Fig. 7.—Curves Used in Fairing Up Lines of Paddle Tug with Straight-Lined Sections

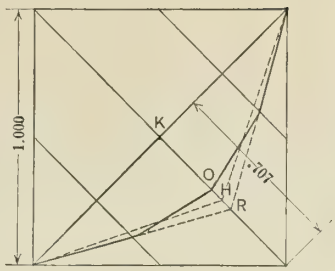


TABLE I

Coefficient of Sections	KO	KH	KR
.500	.000	.000	.000
.550	.058	.071	.084
.600	.116	.142	.168
.650	.173	.213	.253
.700	.231	.284	.337
.750	.288	.354	.420
.800	.346	.425	.504
.850	.404	.495	.586
.900	.480	.566	.652
.950	.582	.637	.692
1.000	.707	.707	.707

figures, it is, therefore, only necessary to know the position of O and R for the particular coefficient desired. Table I gives these lengths for several coefficients from which cross curves on base of coefficient of fineness of section can be drawn. Fig. 2 shows this series of figures up to all coefficients. A slight modification to these sections must be made for structural reasons, when coefficients exceed .900 and this modification is also shown.

The procedure for designing a set of lines is as follows:

1. First draw in the areas curve and load waterline curve on a base of 25 inches, and having unity as the maximum ordinate as shown in Fig. 3. If there is no trim, the coefficient h of any section B is obtained by dividing the areas curve multiplied at B by that of the load water plane and multiplying the result by the coefficient of the middle section. These coefficients are then plotted

TABLE II

Where m = coefficient of maximum section

Number of Station	L.W.P. ordinate multipliers.	Sectional areas curve ordinate multipliers	Mean draft considered unity. Draft multipliers	Coefficient of fineness of section = ③ × ④ / ② × ⑤	Diagonal ordinates from Table I.		Functions of tangents at keel = DZ	Correction to ⑧	Final function of tangent at keel	Function of vertical position and actual position of three angular points from keel			Function of horizontal positions and actual positions of angular points from center line		
					O	R				Q	O	N	Q	O	N
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

on the same base, the ends running up to unity in the form of asymptotes. It may be noted for a good design the coefficients forward of midships or maximum section are fuller than aft; also the maximum section coefficient should generally be the fullest in the ship.

2. In two squares (Fig. 4) for the fore and aft bodies the points R for the sections are spotted and the lines CR produced to meet BD in Z. All these points Z are then set off on the 25-inch base and a curve run through (they should, of course, be quite fair). It may be mentioned that this Z curve is only the reverse of the coefficients of sectional fineness—i. e., the first differential. Now, if it is desired to have the ship's side parallel at midships, draw RL (for the maximum section) parallel to the diagonal BC of the square (Fig. 4) to meet BD in L. The curve of tangents must now be modified as follows. Sections at one-fifth of the ship's wetted length for the ends must remain unaltered. Therefore, the new curve will take the form shown, the differences between old and new curves being obtained by plotting the height ZL from the base and joining it to R and S shown on 25-inch base (Fig. 3), the ordinates between these two straight lines and base being added to or subtracted from the old curve, according as the straight lines lie above or below the base. Reference should be made to Sir A. Denny's remarks before the Institution of Naval Architects in London on the method employed by his firm on standardization of ship forms for tank purposes.

3. Take two more squares and spot the new tangent intersections obtained from the modification described above and join them to C (Fig. 5). The new positions of O and R are obtained as follows. For each section from its O and R plotted on the diagonal of the square draw lines parallel to the other diagonal as shown in Fig. 6. The point of intersection of RL with the new tangent CZ_1 gives new position of R, called R_1. Join QR_1. Let the line through O parallel to BC cut QR_1 in O'; then O' is the new position of O. Through S and T draw lines SM and TN parallel to QR_1. Join R_1 to B, then $BNO'MCA$ is the section wanted. After having done this for all the sections, reduce these figures to their respective sizes with regard to beam and draft on a body plan. Fig. 7 gives an actual example of a tug. The sides at maximum section were not altered as described above for simplicity sake. Table II gives detail of calculations involved.

4. As a final fair up, plot all ordinates such as $a\ b$ on the 25-inch length (Fig. 7) and run curves through. If the drawing has been accurate these will be quite fair, any unfairness being corrected in the final body plan, as shown in Fig. 7.

With reference to considerations of construction, each set of angular points can be utilized as longitudinals with widely spaced deep frames, intermediate frames being bracketed to the longitudinals. The exact shape of the side plates can be procured by expansion similar to that for the stern plating round the counter of a merchantman. It is easily seen that the top sides can be suitably worked in, in straight lines, the decks above load line taking the place of longitudinals. The Isherwood type of construction would be especially suitable for these forms. Ferro-concrete ship construction should be much facilitated by the adoption of this type of design.

Summing up, therefore, the advantages to be gained by the adoption of the above system are:

1. All calculations involved in the design are extremely simple.

2. A simplified system of laying off insures the accurate maintenance of the required dimensions and speed in marking out frames, plates, etc.

3. Simplicity of construction especially suitable to ferro-concrete ships.

4. Cheapness because of the small amount of smithing, rolling, etc., required.

5. Adaptability to the longitudinal system of construction.

6. The forms lend themselves to standardization.

7. The angular points follow as closely as possible stream lines, thus reducing resistance.

Four-Masted Schooners Built from Designs of New York Naval Architect

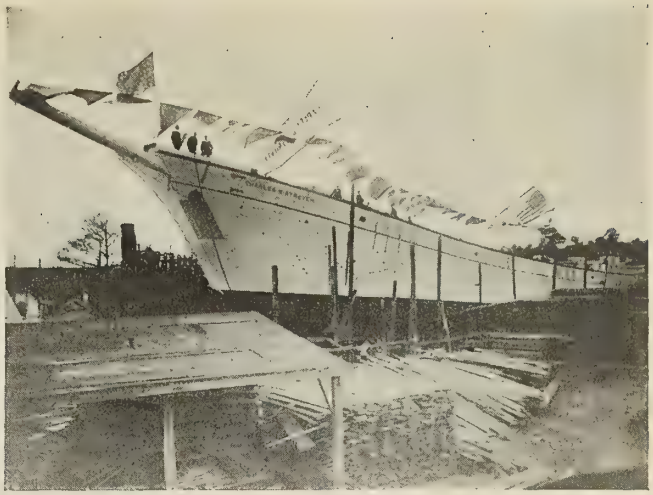
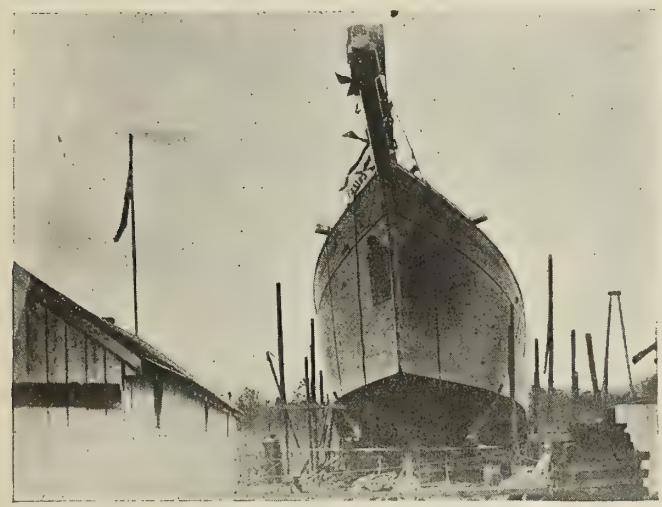
"Ships, ships, and more ships!" is the cry continually heard to-day. Shipbuilding is the most vital industry in the United States, and, incidentally, ships are most essential for the successful prosecution of the war. Henry J. Gielow, one of the foremost naval architects in the country, and senior member of the firm of Gielow & Orr, naval architects, marine engineers and ship and vessel brokers, 52 Broadway, New York City, set about in the early stage of the war to perfect a design of wooden cargo carriers that could be turned out quickly, economically and in large numbers, thereby relieving the tremendous pressure and demand for bottoms. Views of one of a fleet of four-masted schooners just completed in a southern yard from Mr. Gielow's design are shown on page 339. The principal dimensions of the craft are:

Length over all	190 feet 6 inches
Length on waterline	160 feet 10 inches
Beam, molded	36 feet 8 inches
Minimum depth of hold	12 feet 10 inches

The construction throughout embodies the most progressive method used in modern shipbuilding to-day. The keel is of white oak, 14 inches by 14 inches, with scarphs 6 feet long, bolted together. White oak is used for the 12-inch by 29-inch stem and 17-inch sided stern post. The forward deadwood extends up on the stem to meet the apron and runs down on the keel so as to make a good lap. This is bolted through the stem and keel, while the aft deadwood, of white oak, extends down on the rider keelsons and is sided 14 inches. A heavy white oak transom sided 12 inches is bolted to the stern post. White oak frames are used throughout, being 14 inches at the heel and 12 inches at the plankshear. Yellow pine keelsons, three tiers wide and three tiers high, are all scarphed with 6-foot scarphs and thoroughly bolted. Yellow pine, 10 inches by 14 inches is used for deck beams, except hatch beams and partner beams, which are 12 inches by 14 inches molded, 14 inches at the center and 8 inches at the end, spaced four feet on centers, and have hackmatack knees under each end of each beam thoroughly bolted. Three hatches about 14 feet by 18 feet, with yellow pine coaming 24 inches high, and covers of cedar 1⅞-inch dressed, tongued and grooved, are thoroughly ironed on top and inside, and provided with two hatch bars at each hatch to set up with screw bolts. Stanchions are of white oak. Garboards, planking and plankshear are of yellow pine. Decking and stringers are of yellow pine, while the deck beams are of white oak.

The masts are all of selected Oregon pine of the best quality, while the rigging is a special charcoal galvanized wire, all running rigging being pure manila and hemp rope.

A Fairbanks-Morse hoisting engine, belted with drum for hoisting cargo and 6-inch wrecking pump and 3-inch suction pump, is installed.

Views of First of Fleet of Wooden Four-Masted Schooners Building to Designs by Henry J. Gielow, Naval Architect, New York

On her maiden trip the vessel loaded 930 tons of coal at Newport News for Martinique, and made the trip in twenty days, which proves beyond a doubt that she is an exceptionally good sailer. On her return trip she loaded log wood for Philadelphia. Her owners speak very highly of her and state that she loads lumber very easily and can carry 475,000 feet. Her builder stated that he did not believe the lines of the vessel could be bettered in any way, which speaks very highly for her designer. The designer has won world-wide recognition of his ability to design any type of a commercial vessel and obtain the most satisfactory results, which has been proved by the numerous contracts on hand, and already completed, of ferry boats, lighters, tugs, barges and motor ships.

On a Southern trading steamer an oiler used a piece of white mosquito netting about 16 inches square instead of a handful of waste to wipe his face. When hung in a draft it dried almost at once. Great idea, that! Try it.

The man who starts to monkey with the weights of an automatic governor hunts trouble and gets it. Leave them alone.

When cutting rubber, wet your knife—it will make the job easier.

Engineering Education as Applied to Naval Architecture and Marine Engineering*

BY H. A. EVERETT†

THE oldest school for naval instruction and the ranking school in France is the Ecole d'Application du Genie Maritime of Paris, originally established in 1765, but undergoing many changes and removals, finally returning to Paris in 1882 and organizing the present curriculum about then.

The course is a two-year course taken upon the completion of a two-year course at Ecole Polytechnique, the whole corresponding to the four-year course common in engineering colleges here, in which the professional work does not begin till the third year. The ranking men from the course at the Polytechnique have the privilege of selecting the government bureau they wish to be trained for, and naval construction is considered the prize department.

The course throughout lays great stress upon facility in mathematics, and has even been criticised as paying too much attention to this branch. Instruction is given by lectures, drawing-room work and shop work. The daily

* From an address delivered before the Delaware River Branch of the American Society of Marine Draftsmen, February 8.

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routine is a two-hour lecture every morning beginning at 8:30, followed by a question period, with examinations every week. The afternoons are devoted to drawing or shop work. The term is from September 20 to July 1, and the summer period is devoted to inspection trips to navy yards and shops, of which a report and sketches are turned in and are marked as part of the required work. Both summer periods are spent in this, and aside from this very little practical work is attempted.

In Great Britain the Royal Naval College at Greenwich may be considered as the senior school, and, like that just mentioned, educates men primarily for naval constructors. The course as now given was established at Greenwich in 1873, though there has been some instruction given prior to this at South Kensington.

The Royal Naval College at Greenwich

Entrance to the Royal Naval College is via two routes, one by examination, and in practice this is open to all British subjects, and two by selection from the training schools for dock-yard apprentices. As these latter furnish the bulk of the candidates, a brief description may be of interest. They were established by the Admiralty in 1843 under the name of dockyard schools, but very materially revamped in 1905. There are six of them (Chatham, Sheerness, Portsmouth, Devonport, Halbowline, Ire.), and another is soon to be established at Rosyth.

Boys fifteen to sixteen years old become apprentices in the dockyard as a result of a competitive examination held annually, and the apprenticeship covers six years. They are classified into two sections according to their position on the list of successful candidates. The better section (upper school) attend school on two afternoons and three evenings per week for four years. Apprentices who complete this course and show especial merit are recommended for cadetship in naval construction, and if appointed are given a year's course of combined theoretical and practical instruction at one of the large home dockyards before proceeding to the Royal Naval College at Greenwich for a further course extending over two or three years. On completing this, those who obtain first or second class certificates on their final examinations are confirmed in the Corps of Naval Constructors as assistant naval constructors, second class.

At Glasgow University the course in naval architecture was established in 1883. It consists of a three-year course, with the professional work beginning in the second year. Entrance is by examination, and the men are expected to obtain practical work in the yards during the summer recess.

Night Courses in Great Britain

Much of the educational work of a grade just below our college grade is carried in Great Britain by night courses, and some of the major organizations which give excellent evening courses in naval architecture and marine engineering are the Glasgow and West of Scotland Technical College, and Armstrong College, at Newcastle. In these it usually requires about three to four years to complete the equivalent of one year's work in a college with day seniors.

In Germany the most prominent engineering school is the Technische Hochschule, at Charlottenburg, just out from Berlin. This was established in 1879, but the department of naval architecture was not established till 1894. Here the student enters from a gymnasium after working in a shipyard for six to twelve months. The course is a four-years' course, and there is a distinct segregation of the work on hull and engines into two distinct branches, one man not taking both, and the degree given specifically states the branch taken. There are two sessions, October to April and April to August, and two examinations are required, one after two years' residence, and the other final. Practical work in the yards is a requirement for graduation.

In Japan, a course in naval architecture is given at the Imperial University of Tokio, consisting of three sessions of ten months each, September to July, and during the three years students are required to spend eight months in practical work. They are allowed to select the work, but the faculty supervises progress and reports to the university for marking. Tuition is $12.50 (£2/12/1) per session.

American Schools of Naval Architecture

In this country the parent school is the Massachusetts Institute of Technology, in which the course in naval architecture and marine engineering was started as a branch of the course in mechanical engineering about 1896. Here the course is a four-year course with the professional work beginning in the second term of the second year. Experience in shipyards during summer vacations is urged, but not required.

This college also maintains a course of naval construction which is a special course for the training of the naval officers who are to become naval constructors. These men are graduates of Annapolis, and have had sea experience before being sent to Boston for the technical training.

The University of Michigan has also maintained a separate course in naval architecture which in essentials is much like that just outlined.

So much for a statement of facts concerning the present status of representative major grade colleges, and it is readily noticeable that, allowing for minor variations, they all have these same essential features, approximately a four-year scientific course, instruction on the lecture system supplemented by text, and large periods devoted to design in the drawing room, which are intended to permit the application of the instruction in the lecture room to concrete problems. Practice in actual construction is, however, left largely to external sources rarely controlled by the college, and returning to the student much or little dependent upon circumstances and his enthusiasm.

Teaching Methods

Wm. Barton Rogers, the founder of the Massachusetts Institute of Technology (which was the pioneer in the laboratory system of technical education in this country), is credited with the motto "Learn by doing," and this was the basis of the success of that organization and is vital to the success of any engineering instruction. That this was clearly recognized by those responsible for the development of the course is evident by the effort made to follow up the lecture-room instruction on the major problems by actually doing similar ones in the drawing room. But *why was this not extended to cover the instruction given in ship and engine construction and manipulation?* The answer is threefold:

a. The manner in which courses in naval architecture and marine engineering came into existence.

b. The small number taking the course.

c. Expense involved to furnish proper laboratories.

Taking these up in the order given, we find—(a) that practically all of the courses were outgrowths of the mechanical or civil engineering courses, and where the laboratory system had been applied to them the attempt was made to utilize the laboratories then existing, with

perhaps minor augmentations and changes. Especially is this true of the institutions in this country where we had laid more stress on the laboratory system of education than in European countries.

(b) Naval architecture has always been a highly specialized course, and the need for graduates small as compared with the need for graduates from the two older parent courses. This has meant either smaller corps of special instructors for the students or their taking certain work in conjunction with sections of the larger courses; in which case the small group invariably suffers.

(c) The question of expense is, of course, a very important one, especially considering the chronic poverty of most educational institutions, and even if this unfortunate condition be not present it is improper to make large expenditures unless we get large returns. This matter has been far more of a bugaboo than it should have been. The greatest opportunity for improvement in this country lies along the direction of improved laboratory facilities and instruction in the so-called "practical details."

Instruction in Practical Details Lacking

For many years I was associated with the Massachusetts Institute of Technology, and during that time the criticism that most commonly came back to us was the deficiency in knowledge of details of construction or operation. We took the attitude then, and I believe the correct one, that it was impossible, *as equipped,* both as to personnel and material, to give complete instruction along theoretical lines and also give much attention to practical details. If either were to be sacrificed, it were preferably the latter. A man could get the latter away from college, but rarely the former, and it was better for a man to pick up the practical details after graduation and receive some compensation (though perhaps small) while doing it than to attempt to get this during an academic term for which he is paying tuition. Needless to say, this is the stereotyped argument, and the more I see of the results of the present system, and the closer I get to the graduates, the more certain I am that the criticism is to a large extent warranted.

Obviously, a course cannot survive without some attention to practical features, and, on the other hand, one devoted entirely to practical details simply becomes a vocational training course. As existing in this country and France, the connection with the practical details of actual practice has been only via the cheap and easy route of the drafting room of the college, which has resulted in a serious deficiency in training for men who go on to outside work.

Conditions in the Shipyards

In any country the growth of engineering courses follows the economic history of the subject taught, and in this country that history consists of two crests of activity with long periods of depression preceding. Considering modern training only, the first course in this country was established as a separate course in 1896 at the Massachusetts Institute of Technology, though it had been carried as an option in the mechanical engineering course for several years before that. At this time there was a gradual increase in shipbuilding activity, reaching the first crest in 1902 at the time when it was expected the shipping subsidy bill of Mark Hanna would be made law.

The failure of this measure to pass pricked the bubble of expansion in the shipbuilding industry and there followed a long period of depression, only ended by the enormous activity of the present time. Practically but two organizations of major grade survived that period of extreme depression and maintained separate courses of instruction in naval architecture and marine engineering. These were the Massachusetts Institute of Technology and the University of Michigan. Now, with the present activity many are reviving former courses and establishing new ones, but I have not yet seen any radical departure from the above orthodox course.

The situation is really serious, for the men now issuing from the colleges should be the ones responsible for shaping the development of the industry and form the skeleton of *highly trained* men, about which can be built the organization of both shop or yard and office. But with the deficiency in practical knowledge of even the commonest outside functions many will not find themselves until the crest has passed and the opportunities for advancement seriously curtailed, and the places which they should have taken will be filled by the man taken from the ranks or the lower grade training schools who is facile in construction details but usually lacking the sound fundamental training. This may result in apparent present success, but will be bound seriously to handicap sound and aggressive development in years to come.

This is the reason for the current discussion as to whether the engineering schools have made good in the present emergency, and to my mind in these subjects they have *not* made good, at least to the extent that they *should.*

Do not confuse, and do not imagine that I am confusing, the scope of the college course with those of the secondary or training courses, for I am not. But the principal criticism of the major courses to-day lies in *insufficient development of the training in practical construction and operation.* I do not believe in destructive criticism. If one has no remedy to suggest, good is never done by calling attention to defects. I will therefore venture my opinion as to the best correction for the above-mentioned fault.

Remedy Suggested

The trouble can be entirely eliminated by doing three things: (1) Enlarging the purely professional teaching personnel; (2) providing a proper laboratory equipment and courses, and (3) providing an effective alumni employment bureau.

The need for the first is almost self-evident. There should be a man of faculty grade to handle *each* of the major professional subjects, so that he can give complete attention to its presentation and receipt. Sufficient instructors and assistants should be provided to ensure sections in the drawing room not exceeding ten men, and in the laboratory not exceeding five. This, coupled with a good system of marking at frequent intervals, will ensure that the teaching of the fundamentals penetrates permanently.

The second, namely, proper laboratory equipment, is fully as important as the first. The idea that a proper laboratory equipment in this case means a shipyard is as fallacious as that an electrical laboratory needs the Niagara power plants; but who would consider the giving a course in machine tool operation without a lathe to work on? Is it not just as foolish to attempt to teach fabrication of steel members for a ship without a punch or shears? And yet I do not know of a single school in this country that has a shipyard punch or shears for instruction purposes in its shop or laboratories.

Nor can the argument of expense be legitimately forwarded, for the expense of a single power-producing unit in any modern mechanical laboratory will far exceed the

cost of the most ambitious ship tool that one could wish to establish in a ship-construction laboratory. A few of the principal shipyard tools of sufficient size not to be trivial, material to work with and a space for some erection, is surely a modest programme for a ship-construction laboratory; and for a marine engineering laboratory an equipment of the principal auxiliaries arranged somewhat like aboard ship, with customary laboratory facilities for operation and test, would suffice. The prime mover could be located in the mechanical laboratory if necessary and serve two purposes, and the boiler could be of the regular plant equipment.

Employment Bureau for Technical Graduates

Passing to the third suggestion, an efficient employment bureau, it is of as vital importance that any product be properly marketed as that it be properly produced. The first two items deal with improved production; this, with improved marketing of the finished product—the graduate. Most of the colleges of this country maintain more or less efficient organizations for answering requests for men. Usually the bulk of the actual work of selecting individuals for all the courses falls upon one or two members of the faculty, and this in addition to their other duties. If we are going to rely upon a man obtaining most of his practical experience after he leaves the college, and we must, even though we give him some, as suggested above, then the college should exercise careful supervision over the graduates' occupation on leaving, and should encourage frequent movement during the first few years after graduation. This employment bureau should keep in constant touch, not less than once a month, with the recent graduates. It should deal specifically with one department, and no other, though receiving requests forwarded from other branches, and should encourage rather than discourage changes that make for the advantage of the graduate; in fact, it should be almost parental in its efforts for direction and guidance of the graduates on matters of professional occupation and advancement.

It is considered against the ethics of the profession for individuals to advertise in certain channels, but there could be no objection to a properly constituted central body advertising by press and circulars to the shipping fraternity a list of anonymous individuals of various training, experience and capabilities, who wished to change their fields of activities. This would be a stable arrangement, as it would result in benefits to both sides—to the employer, in that he could see what the market had and current quotations, and to the graduate, in that he could change to a field that needed a man of his training, much more readily, and thus improve his changes for advancement.

Kinds of Employment Available

It should be one of the functions of this organization to cultivate new channels for the employment of graduates. I have found men so many times going directly into a shipyard simply because they didn't know there was any other place for them to go without changing their profession that I am convinced that both the public and the graduate need enlightenment on this subject. Of course, the immediate field is the shipyard and will always be the predominant user of graduates, but with a country with the shipping interests of this one there are many and varied positions that could and should use the trained technical man. Such places as naval architect and superintending engineers for the large steamship-owning companies, surveyors for the American Bureau of Shipping, resident constructors for steamship companies having vessels built, supervising inspectors for the United States Steamboat Inspection Service, with marine supply companies, purchasing agent, etc., etc., all would be infinitely benefited if filled by men of sound technical training. Proper publicity and advertising campaigns would result in opening up the lines to these positions for the young graduates and also in many cases for the older men, who may be side-tracked into routine work with limited prospect for advancement. I feel very strongly that the graduate should have an active, aggressive and, if needs be, selfish agent who will look after the *graduate's* needs first and to the best of its ability.

Let me briefly summarize; the courses as established are sound in their treatment of theoretical subjects and in the apportionment of time allotted to these subjects and to the application; they do not, however, use the time apportioned for the *application* of the subjects to good advantage. If the time available for drawing-room work and laboratory work were properly utilized in practical problems and in laboratories properly equipped for teaching details of construction and operation there would result a better trained graduate, one who would not go out into the field of his profession with the placid and complete ignorance of important details, as now frequently happens, but are equipped to stand shoulder to shoulder in practical work with the man coming to the task from the other route.

Standard Cargo Boat Built by Moore & Scott Iron Works

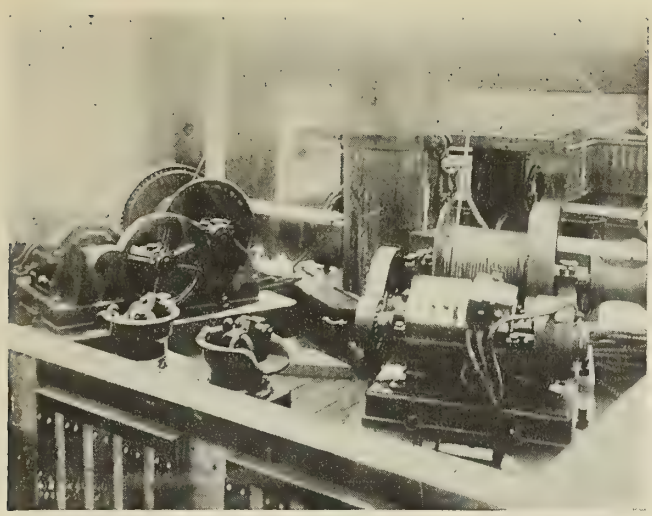
MOORE & SCOTT Iron Works, San Francisco, Cal., is prepared to build cargo vessels of a standard type capable of carrying 9,400 tons deadweight on Lloyd's summer freeboard (about 26 feet 4 inches draft). The vessel is of the shelter deck type, designed for a speed of 10½ knots and fitted with either turbine or reciprocating engines. The principal dimensions are as follows:

Length between prpendiculars.....402 feet 6 inches
Breadth, molded .....53 feet
Depth, molded to upper deck.....26 feet 6 inches
Depth, molded to shelter deck.....34 feet 6 inches
Cubic capacity, including 425 tons of coal in permanent bunkers, approximately.....427,000 cubic feet
Cubic capacity, exclusive of permanent bunkers, approximately .....411,000 cubic feet

Built on the Isherwood system of longitudinal framing, the vessel is of schooner rig with two-pole masts, each fitted with four 3-ton derricks. Cargo is handled through four hatches, each 20 feet by 33 feet, and one hatch 8 feet by 20 feet. Amidships there is a deep tank for water ballast. A refrigerating plant is provided suitable for keeping the temperature of the meat room at 24 degrees, and of the vegetable room at 34 degrees.

Propulsion is by a single-screw driven by either a reciprocating engine or steam turbine supplied with steam by either Scotch or watertube boilers. If turbines are installed, the boiler pressure is 210 pounds per square inch; if reciprocating engines are installed, the boiler pressure is 180 pounds per square inch. The designed horsepower of the engines is 2,400 and the coal consumption approximately 45 tons per twenty-four hours.

The auxiliaries include one 20-ton evaporator, one feed heater, two turbo direct-current, 110-volt, 10-kilowatt generating sets and one distiller of 2,000 gallons capacity. The deck machinery includes one 10-inch steam windlass on the forecastle deck, one winch on the poop deck with extended warping ends, eight 7-inch by 10-inch vertical winches for working cargo, and two 7-inch by 10-inch vertical winches for working the hatch at the bridge front.



Showing Minimum Deck Space Required for Winches

Electric Winches Are Operated and Controlled Easier than Steam Equipment

Electric Winches Gain Favor on Motorships

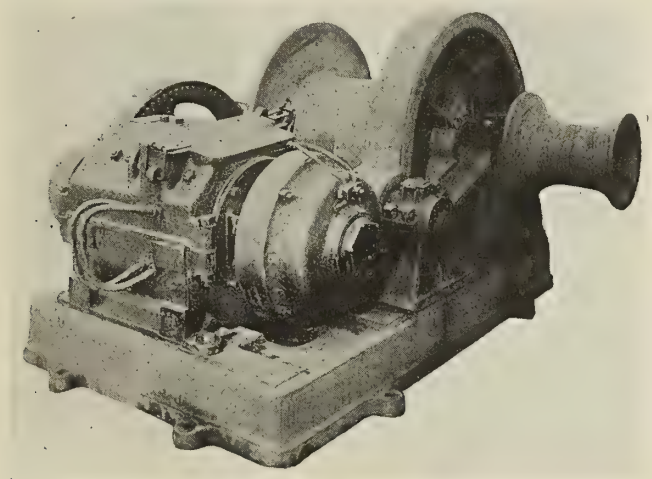
Record in Cargo Handling Attracts Attention—Fifteen Freighters Equipped by Seattle Firm—Economy Gained in Operation and Upkeep

WITH the advent of the motorship and the absence of the usual steam propelling power the question of power for auxiliary machinery on shipboard has been studied anew. Electric motors have been applied to much of the work, and in handling cargo the motors have been shown to be much more effective than the old steam apparatus. On September 1 fifteen boats had recently been or were being equipped with electric winches by one firm in Seattle, Wash., which has specialized in this line, and on those boats which have already been put in service very satisfactory records have been made.

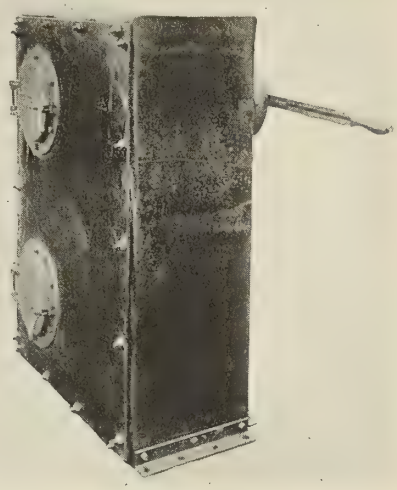
The first cost of electric equipment is considerably higher than for steam winches; but offsetting this are a number of important advantages. The electric winch is more economical to operate; it is claimed that it cuts loading or unloading time in half, affords much better control of the load, eliminates standby charges that increase steam operation costs when delays occur, makes the winches available any time on short notice and eliminates trouble from frozen steam pipes or cylinders. With the watertight motors now used, exposure does not affect the deck equipment, and with conduits properly installed the maintenance and repairs are believed to be below the corresponding costs on steam equipment.

Type of Equipment Used

Since variable speed at variable loads is essential, direct current is used exclusively, the specification calling for 220-volt Crane type motors. The installations referred to in the foregoing are as indicated in the accompanying table:



Single-Drum Electric Winch



Controller

Owner	Number of Ships	Winches per Vessel	Winch Power, H. P.	Winch Capacity, Tons
A. O. Anderson & Co.	3	6	15	2
A. O. Anderson & Co.	5	6	25	4
Libby, McNeil & Libby	1	6	20	3
Libby, McNeil & Libby	1	4	20	3
Alaska Pacific Steamship Co.	2	4	15	2
M. T. Snyder Co.	1	2	15	2
Independent Steamship Co.	1	4	10	1½

All but the last are 2,800-3,000-ton wooden motor ships.

The first of these boats to be put in operation was the *Astoria,* with six 15-horsepower, 2-ton winches. This boat went into service immediately after leaving the yards, and on the first day's loading green crews put aboard 453,000 feet board measure of lumber in eight hours. This is estimated to be about three times the amount of cargo that could have been handled with steam equipment. Moreover, conditions were adverse on this day, as a gale was blowing and 5 inches of snow lay over the lumber piled on the wharf.

The greater speed with electric winches is credited to the degree of control which the operators have over the load. It can be dropped rapidly to within a few feet of the bottom of the hold and then slowed down to enable it to be swung into place. The return of the empty hook is also made much faster than with steam winches. The 4-ton hoists on the *Astoria* handled capacity loads at about 100 peet per minute, and the same equipment, without change in gearing, lifted 2,500-pound loads at about 300 feet per minute on a single line.

The positive unwinding drive of the electric winch brings down the empty hook as rapidly as desired. Should the current fail during operation, the automatic brake will hold the load suspended until the current comes on again. The motors are protected against overload on low voltage by a double point circuit breaker and contactor panel. If an overload comes on the circuit breaker goes out and is cut in again automatically when the control lever is returned to neutral position. The winches thus far used are of the single-drum type, so two are required for each hatch. However, a single lever controls each winch, and no foot brakes are required. It is notable that levers and directions of movement are the same as in the old steam winches, so that new operators have no difficulty in "breaking in."

Saving in Cost and Space

The direct-current generators are usually put in the engine room, where space is not valuable, and are driven by Diesel or semi-Diesel stationary type oil engines. This saves deck space and keeps the generator sets where the engine room force can attend to them. The fuel consumption is remarkably low. For example, a Swedish motor ship with electric winches, which recently docked at Seattle, loaded and unloaded about 7,000 tons of freight, 14,000 tons in all, with an oil consumption of 1.7 tons, which is estimated to be about one-tenth the oil that would have been required to generate steam for steam winches to do the same work.

The usual comparison is that a Diesel engine driving a generator will consume less than ½ pound of fuel oil per brake-horsepower hour as against 5 pounds or more of coal per horsepower-hour that would be required for a donkey boiler and steam power. Losses on the electric conductor between generator and motor are negligible as compared to that in steam lines, not to mention the difference in efficiency between the electric motor and the reciprocating steam engine.

The Diesel engine-driving generators in the motor ship will take the same kind of fuel as the propelling engines, and takes its circulating water from the sea, thus dispensing with the separate fuel tanks, fresh water tanks, condenser and other inconveniences that are inseparable from the steam plant.

Trouble heretofore experienced with electric machinery above deck is believed to be due very largely to inadequate protection from salt air and water. As now installed, the motors are not merely weatherproof, but are made absolutely watertight. The controlling apparatus is enclosed in a watertight steel case with two watertight doors, which can be opened for ventilation during use. The lever shaft which operates the controller is carried through the side of the control case in a stuffing box, packed like a piston rod. Wires are led through watertight conduit. The motors are direct geared to the winding drum, and friction drums and hand brakes are entirely eliminated.

Just as the Shipping Bureau requires motorships to carry certain spare parts, so should the electric winches be protected against breakdowns that could not be repaired en route or in freight ports.

The vessels described in the foregoing have been electrically equipped by the Pacific Machine Shop & Manufacturing Company, of Seattle, Wash., under the direction of Allen Cunningham. The motors and control apparatus were supplied by the General Electric Company.

Propeller Shaft and Broken Propeller

The illustration shows an experience with a propeller and shaft due to working amid water mingled with sand under the following circumstances. The steamer was trading between Monte Video and Paraguay, and in the course of the voyage up river she fouled a sand bank; the engines were kept moving to get the vessel off. The chief

Damaged Condition of Propeller and Shaft

engineer, finding the engines to be increasing unduly in speed, reduced the steam inlet, but after some eighteen hours' work they were pulled up. When the vessel was brought into dock for examination it was found that the shaft, the original diameter of which was 6⅜ inches, was reduced to 1¾ inches, thus giving a play of 4¾ inches in the outer bearing of stern bush, while two of the propeller blades, which were of cast iron, were broken and the other blade of gun metal was buckled at the tip.

The shaft was lined with gun metal and the stern bush was similarly lined. The vessel has twin screws, and the illustration shows the port propeller shaft. The propeller is three-bladed, and at this period of its history was fitted with two cast iron blades and one of gun metal. Had the stern bush been fitted with injection lubrication or clean water pressure, to keep the sand out of the bearings, it is interesting to consider whether the damage would have been avoided, or at least minimized.—*The Marine Engineer and Naval Architect.*

Fig. 1.—Starboard Side of Sunken Tanker a Few Minutes After Buoyancy Was Given the Vessel by Compressed Air

Salvage of the German Tanker Gut Heil

Compressed Air Raises 6,000-Ton Vessel After Lying Five Years on Bed of Mississippi River

BY ROBERT G. SKERRETT

THE German tanker *Gut Heil,* a vessel having a load displacement of about 6,000 tons, has lately been refloated, after lying substantially five years on the bed of the Mississippi a half mile below the city of Baton Rouge, where the Standard Oil Company has large refineries. As a salvage achievement, the raising of the steamer is noteworthy because the successful wreckers had to combat very hampering conditions.

Fig. 2.—The Ship in Process of Righting

How the Vessel Was Wrecked

The ship had just finished taking aboard a large export cargo of oil in 1912, and was getting well under way from the plant when she fouled her screw with a chain cable, became unmanageable and was carried by the current down upon two other vessels, each of which cut through her hull plating. One wound was abreast the engine room and the other in the compartment just forward, and both on the port side. The *Gut Heil* filled rapidly and sank in a few minutes. Some time later the same year her salvage was undertaken, and the work progressed to a point in rather a promising fashion. Unfortunately, her buoyancy was not wisely controlled. With her bow rising sharply and her stern still down, she acquired a heeling moment that could not be checked. In consequence, she turned over far enough to refill and to settle to the bottom on her injured side, leaving her starboard side just about flush with the river surface. That unsuccessful effort to refloat the *Gut Heil* cost the Standard Oil Company—her underwriters—a matter of $125,000 (£25,600).

For more than four years thereafter the steamer lay undisturbed, abandoned by her insurers, and treasure

Fig. 3.—One Stage Further Along in Getting Back to an Even Keel. On the Left Air Is Escaping from a Relief Valve, while on the Right the Disturbed Water Is Due to Air Leaking from a Small Hole in the Temporary Sealing of the Wound in Compartment No. 7.

trove for anyone that might seek to effect her raising; but her position marked her an unpromising gamble, and no one seemed disposed to risk good money upon her until a short while back, when President Underwood, of the Erie Railroad, and a number of his friends provided the funds and employed the Yankee Salvage Association, of New York city, to essay the task, after the experts of the latter concern had made an examination of the wreck. The ship was refloated early in December, and that climax represented the culmination of two months of painstaking preparation and work.

Ingenuity Required to Remove the Silt

During her long submergence the tanker's cargo of oil escaped, and in its stead her various compartments became loaded with a round measure of 4,000 tons of silt. The salvors' first problem was to get rid of this mud in order to dispose of that troublesome deadweight and to facilitate a thorough examination of her internal structural condition. Three thousand tons of the mud was discharged by means of special apparatus built for the job. This was in the form of compressed air siphons—the compressed air serving the double purpose of stirring up the mud and of producing a "lift" to bring the silt to the surface. The arrangement was an ingenious and effective one.

Upon inspection, after the removal of the mud, the divers found that the centerline bulkhead, which extended from the engine space forward through all of the tanks, was not tight where it joined the decks above. Inasmuch as the wreckers had elected to depend upon compressed air to refloat the ship, it was necessary that the junctions with the two decks should be sealed. This was done under water by tapping the bulkhead from its upper side contiguous to each deck, doing the same with the decks at the neighboring intersection, and then screwing into place bolts with broad heads. Concrete was then molded about the bolts, forming, in section, a rectangular tie between the nearby metal surfaces. This binder made the junctions perfectly secure and air tight, so that each compartment could be dealt with separately in the distribution of water ballast or buoyancy. The two injuries in the side of the ship were closed by reinforced concrete.

Where possible, air connections for the pressure system were tapped into the starboard tanks through the upturned side of the *Gut Heil* and located at points where they would be low down when the ship began to right herself. All discharges from the mud excavators were brought to the surface so that the salvors could observe just what the apparatus were dealing with. This was a visible check upon the effectiveness of the siphons and the gradual removal of the silt.

For the purpose of centralizing the control of the final stage of the undertaking, all of the flexible connections to the multiple air taps in the various tanks were led to a swinging platform erected upon a temporary extension of the ship's bridge. This platform was pivoted so that it would accommodate itself to the changing position of the craft when rising and heeling to starboard upon assuming a level keel. Attached to an upright grid on this platform were two sets of gages—one set being mercury column gages and the other the usual type of dial gages. The mercury gages marked the buoyancy in the various tanks or compartments, while the dial gages indicated the amount of compressed air in reserve in the salvors' flasks, and, therefore, the available pneumatic energy for dealing with the situation. A complete set of valves upon the same stage made it possible to control every compartment to which air pressure was to be applied. The release of this pressure would permit water to re-enter a tank, while the application of air pressure would drive out the water and increase the buoyancy at that point accordingly. The wrecking master, standing upon this platform, had within

Fig. 4.—Photograph Showing Pivoted Gage Platform and Compressed Air Connections Centering There

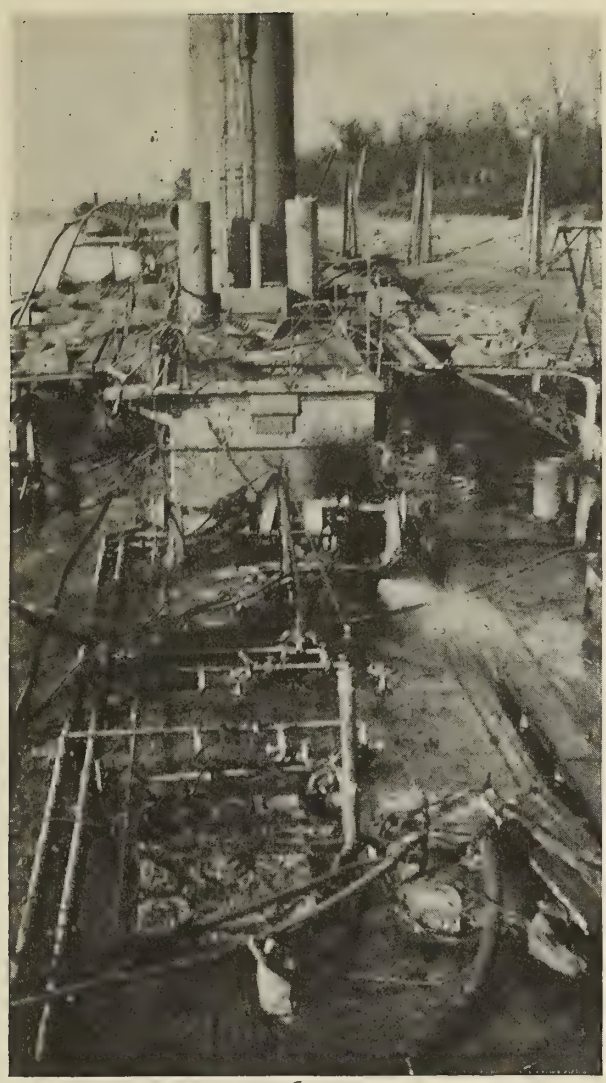


Fig. 5.—The *Gut Heil* Immediately After Her Refloating

a convenient compass everything essential to his perfect manipulation of buoyancy and water ballast, so that he could juggle these forces at any instant.

The Secret of Success

The secret of success lay in keeping the *Gut Heil's* bow down as a sort of pivotal point while her buoyancy was increased from the stern forward and from her under side. In this way the boat was to be brought to the surface and heeled over until upright—the bow contact with the river bed serving to stabilize the operations by giving the wreckers, as it were, a footing on the ground. The previous unsuccessful attempt to refloat the tanker had emphasized the need of a nice check upon the vessel's lateral movement, lest the righting moment become sufficiently great to swing her too far over and to imperil a second sinking.

The tanker was first given sufficient buoyancy to just get her clear of the bottom and to make it possible to swing her into shallower water, where, when settling again upon her side, she raised her upper bulwark several feet above water and at a more favorable angle—that is to say, with her upper side no longer flush or parallel with the river's surface. With everything in readiness for the final effort, buoyancy was again given the submerged side, and the boat steadily righted until the top of her smokestack was showing above the tide; but then further movement was arrested by the readjustment of 1,000 tons of mud that had not been removed. This dropped away from upper surfaces, where it had been clinging, and thus changed materially the center of gravity of the craft. For something like three hours the *Gut Heil* hung at that point, and then, as added buoyancy was brought to bear, she gradually righted herself. The mud really served a useful purpose, because it acted like a counterweight and tended to play the part of a brake upon the vessel's angular movement.

After getting the tanker entirely afloat, the wreckers found her machinery in exceptionally good condition, notwithstanding its long submergence and its overlay of mud. In fact, nothing more radical than a good cleaning has been found needful to put her machinery in condition to carry the boat under her own power down to New Orleans for permanent repair. When the ship was sunk in 1912 it would have cost approximately $300,000 (£61,500) to replace her. To-day, thanks to the increased value of seagoing bottoms, the craft is well worth a round million (£205,000). It is said that her present owners, if they sell her at that price, will certainly clear between $700,000 (£143,200) and $800,000 (£164,000) upon their venture.

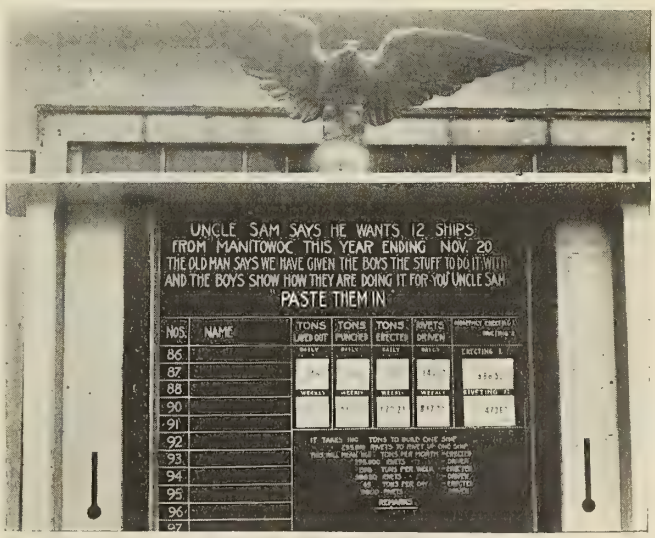
Shipyard Score Board

To indicate daily and weekly progress on vessels building in the yard of the Manitowoc Shipbuilding Company, Manitowoc, Wis., the bulletin board shown in the accompanying illustration has been erected by the company, with the result that a wholesome rivalry has been stimulated among the employees.

On the board is shown the daily tasks assigned to the riveters and to the erection men in order that the building programme may be completed on time; also a statement of the corresponding number of rivets and number of tons of material to be handled weekly and monthly.

The anticipated erection schedule by weeks is charted on one side of the board, and on the other is a corresponding schedule for rivets that should be driven each week. Against these desired amounts is marked in the form of a thermometer the actual progress in erection and riveting at the end of each week.

In this manner an immediate comparison is secured between the actual progress made at any date and the corresponding progress that should have been made. In other words, the bulletin board shows the workmen just what they have done and just what they should do. The bulletin, therefore, becomes the shipyard score board.



Bulletin Showing Progress of Work at Manitowoc Shipyard

Fig. 1.—Fifty-Foot Angle Furnace, Showing Preheaters, Vaporizers and General Construction

Economical Method of Burning Fuel Oil

Fifty Percent Increase of Economy Claimed for Sklovsky, or "Oilgas," Furnace Developed by General Combustion Company

WITH the great increase in the use of fuel oil for furnace work in the ammunition and shipbuilding plants, and the greatly increased prices of this commodity, all operators are looking at the present time toward any suggestion that will tend toward economy in its consumption. The General Combustion Company, of Chicago, has introduced a new method of burning fuel oil for which increases of economy as high as 50 percent are claimed. A claim of much less economy would be interesting at this time; but with a saving of approximately one-half the oil involved, the following explanation of the process as supplied by the manufacturers will be of interest:

The process is the result of an exhaustive investigation made by one of the largest forge shops in the country, which, realizing that the cost of oil was steadily increasing, sent its chief engineer on a six months' trip to England, Belgium and France, as well as throughout this country, with instructions to examine every possible substitute for fuel oil. The price of fuel oil has been continuously on the increase, and it was realized at this plant that some method must be obtained whereby they could decrease this enormous item of cost. It was thought possible that perhaps a producer gas plant would give satisfactory results. Also, the use of powdered fuel was given careful consideration. The result of this investigation proved that this shop could afford to pay as high as 15 cents (0/7½) per gallon for oil before a substitute would prove a better investment. The possibilities of decreasing the cost of fuel for this type of furnace were not in a substitute for fuel oil but rather in more efficient methods of burning it. The engineer mentioned set about a scientific study of fuel oil. He investigated its technical and mechanical properties and its behavior under various conditions of temperature and further influences. As a result, the Sklovsky method of burning oil was brought into effect, which resulted in the saving of 67 percent in fuel oil in this particular shop. After several years, the Patent Office has finally granted a broad basic patent, dated June, 1917, covering the complete process.

It is readily recognized by furnace engineers that the most efficient way of burning oil would be to burn it in a gaseous state. If the oil could be changed into a gaseous state, then complete molecular mixing could be accomplished without any trouble and with a great increase in economy. Under this improved condition, it would be possible to operate with just the theoretical amount of air necessary for complete combustion or 100 percent air. Combustion would take place much more rapidly and be completed in a fraction of the time needed before. It would now be possible to heat the stock with the gases after they had been thoroughly burned, so there would be

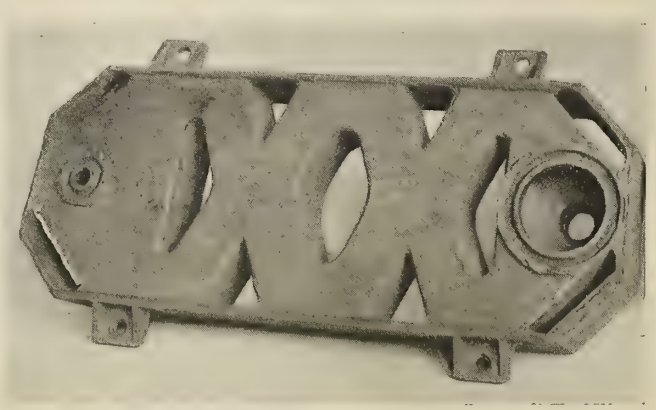


Fig. 2.—Preheater, Where Incoming Air Is Heated to High Temperature by Waste Gases From Furnace

no free oxygen to scale the stock. Using only 100 percent air would mean much higher flame temperature, and this would cause the stock to be heated much more rapidly. A still further economy could be made and still higher efficiency obtained by using the waste heat to preheat the air for combustion and to reduce the oil to its molecular state. Economy could also be made by reducing the furnace radiation losses.

Vaporization of Oil

In the *"oilgas"* furnace, vaporization of the oil takes place before entrance into the combustion chamber. Likewise, mixing of the vapor of the fuel oil with the air takes place before entrance into the combustion chamber. With these two conditions, the fuel entering the combustion chamber mixed in the gaseous form ignites more readily; in fact, almost instantly, and very completely. The fuel, therefore, burns with more nearly the chemically exact amount of air than is possible in previous types of oil-burning furnaces. The thorough mixing prior to entering the combustion chamber is accomplished by agitation that occurs in the vaporization chamber, due to the form of the chamber and velocity of the air, which is constrained to move alone without expansion. Another condition that exists in more rapid combustion in this new method is that the mixture leaving the vaporization chamber is approximately 800 degrees in temperature. It is necessary to raise this mixture only about 300 degrees in place of 1,000 degrees within the combustion chamber before ignition takes place.

The high furnace temperatures obtained by the *"oilgas"* furnaces are due primarily to limiting the quantity of air entering the furnace to a proportion nearly approaching that of the chemically required ratio. Also in a measure due to the preheating of the air. It is to be noted that the preheating of the air does not result in a like advance in temperature within the furnace.

The effect of temperature upon the rate of heat transference has been made clear through a set of experiments conducted during the year of 1913. It has been determined that to raise a piece of stock to a temperature

Fig. 3.—Vaporizer, Where Hot Air and Oil Are Mixed Into "Oilgas"

Fig. 4.—Small Plate Furnace, Showing Preheaters and Vaporizers

of 1,500 degrees takes twelve minutes in a 1,600 degree furnace; four minutes in a 2,000 degree furnace; two minutes in a 2,500 degree furnace; 1.2 minutes in a 2,700 degree furnace. It takes, therefore, ten times the time to heat a piece of stock to 1,500 degrees in a 1,600 degree furnace as it does in a 2,700 degree furnace. The economy of more rapid heating under such circumstances is quite apparent, and particularly so in view of the fact that the oil required to obtain high temperature in furnaces does not increase with the increased temperature. This remarkable result is explained by the simple fact that as the temperature of the furnace increased and the vaporization obtained by better preheating of the air resulted in a reduction of the air supply required.

Construction of Furnace

The furnaces consist of the following principal elements:

(*a*) Air heating chamber and preheaters through which the air is forced under pressure and to which the heat is applied externally by the exhaust gases from the furnace.

(*b*) A mixing chamber, or vaporizer, through which the heated air is passed and to which the oil is introduced in a fine stream. The air and oil travel together, and, at the exit of this chamber, the oil has been gasified.

(*c*) The nozzle through which the mixture of vaporized oil and air, or *"oilgas,"* is forced at a high velocity into the furnace.

(*d*) Combustion chamber or furnace proper which is constructed to meet the particular requirements of the heating operations.

Aside from the above four principal elements, there are auxiliary parts, such as air control valves, oil control valves, nozzle and various piping connections.

The air preheaters are designed in such form that any number can be connected together to give the required heating area necessary to raise the temperature of the air to about 700 or 800 degrees with the furnace operating under ordinary conditions. These chambers are designed so that they fit uniformly into each other, no matter how many are used, and so as to have the least weight, taking into account the necessary strength required to withstand the heat and strain. They are also designed as compactly and simply as possible. The air streams cross several times so as to give a mixture of uniform temperature at the exit. Cast iron has proven the most satisfactory material for this chamber. Cast iron, however, must be free from steel, as, when subjected to excessive heat, there is a tendency to scale when steel is mixed with the iron. The design of the chamber is such as to eliminate all machine work. The joints are arranged with annular grooves in which asbestos wicking dipped in fireclay is inserted and the parts drawn together while wet and allowed to dry. This forms a sufficiently airtight joint to hold the low pressure that is applied to the casting.

Vaporizing Chambers

The vaporizing chamber is a single casting arranged to be placed near the nozzle of the furnace. The air and oil inlets are at the upper end. The chamber is designed so as to allow a traverse of the mixture of a distance of several feet before it reaches the outlet. The position of the chamber is such that it will automatically drain the oil downward. There is considerable latitude allowed, so that one vaporizer may be utilized for several different sizes of furnaces for different quantities of oil burned per hour. The position of this chamber should be such that it will not receive any material amount of heat from the furnace. It is also necessary to avoid pockets or low points where the oil will accumulate, as this will cause a variation in the instantaneous gas supply at the nozzle. The air connection and the vaporizer castings are not finished except for rough grinding. The flanges are made up with asbestos gaskets dipped in fire-clay and allowed to dry.

The Nozzle

The nozzle consists of a straight piece of pipe, long enough to reach from the fittings below the vaporizer through the outer wall of the furnace. Where it is desirable to spread the flame, as is the case when the nozzle is placed near the roof of the furnace, the end of the nozzle entering the furnace may be flattened. The size of the nozzle is determined by the minimum quantity of oil that is to be used in any particular furnace. As stated in the foregoing, it is necessary to have a velocity at this point high enough to avoid backfiring. The shape of the nozzle outlet in the furnace can be varied to give suitable flame distribution and it can also be divided into several units supplied from the same vaporizer.

The air connection to the furnace is made to a flanged ell which is fastened to the air heater. The other end of the ell is made special to fit into the annular ring of the heater casting. Any type of valve may be attached to this flange for controlling the air supply. Where the connection is made to the bottom casting of the preheater in place of the top casting is a special U-shaped fitting that is used in preference to the ell. On small furnaces, the connection between the heater casting and the vaporizer may be made by a single special casting that is adapted to fit into the space with the necessary connections to both the vaporizer and heater. On small furnaces, this has been found the most satisfactory arrangement. On large furnaces, regular fittings can be adapted for this connection, with the exception that it is necessary to use a special ell for the outlet from the heater casting.

The connection between the vaporizer and nozzle is made through standard fittings as indicated above, the heater castings, as well as the vaporizer, all being made for standard pipe connection. The nozzle is invariably smaller than the pipe connections supplying same. It is necessary, therefore, to utilize reducers at the outlet of the vaporizers to make proper connections to the nozzle. No special care is required in making the connections to the heater castings or from the heater castings to the vaporizer. As the air pressure used is low, the leakage factor is slight. However, the connections at the outlet end of the vaporizer must be made carefully, as, in that case, the air leakage carries with it oil leakage.

Oil Pipe Connection Simple

The oil pipe connection is made in a simple form, namely, by connecting a standard needle valve at the inlet to the vaporizer. The nipple immediately inserted into the vaporizer is made with a running thread, so that the nipple projects through the casting and drops the oil into the air current. The oil pressure at this point is only necessary to overcome the air pressure, which is not over one or two pounds. At the needle valve, therefore, a pressure of about two pounds is sufficient for actual operation. All excess pressure must be throttled down by the needle valve. It is to be noted here that the regulation is much more satisfactory when low oil pressure is used. This is on account of the grit that is present in the oil. When high pressure is used, a very slight turn of a valve or a change in the consistency of the oil makes a large change in the quantity of oil flow.

Starting up with the furnace cold, the process is similar to that used on the regular atomizing type of furnace. The air is turned on partially and a torch placed into the furnace in the vicinity of the nozzle entrance. The oil valves should be opened slightly, i. e., just cracked. As the air tends to heat up, the oil may be turned on gradually until the flame reaches out beyond the furnace. The vaporizing chamber at the start acts as a crude atomizer, and, as the air is heated, vaporization commences to take place. As also in the regular atomizing type, the initial oil required is greater than when the furnace is thoroughly heated up.

When the furnace is once heated, the starting during the day, after intervals of rest, does not, of course, require any torch.

In shutting down the furnace, the oil should always be shut off first, completely. The air pressure should be allowed to continue for a few minutes, full blast, so as to carry out completely all of the oil from the vaporizing chamber and its connection. The air should be then turned off, but not completely. It is best to leave the air blast on partly for a period of three to five minutes so as to cool down slightly the extreme hot surface of the furnace and thereby protect the nozzles from partial destruction.

The air heaters are so proportioned that they will give the required heat to the air for the average operation of the furnace. When furnaces are operated for appreciable periods of time idle, i. e., without any burden or stock, the escaping heat is necessarily high and the air chambers are overheated to an extent where the air may be given too high a temperature. To avoid this, the air heaters are by-passed, allowing some of the escaping gases from the furnace to be shunted to one side, to avoid overheating.

In addition to an economy of 50 percent in oil consumption, it will be seen from the above explanation of this

new process that positive control is afforded over both air and oil supply through the respective air and oil valves. The result of this is to enable the operator to secure at will either a neutral or reducing atmosphere in the combustion chamber according to the percentage of air mixed with the oil and thereby reducing all oxidation of the stock to a minimum.

Likewise, due to the high flame temperatures which are obtainable with the *"oilgas"* mixture, production can be greatly accelerated, and it is claimed for these furnaces that they can produce, an average of 50 percent more stock than is otherwise obtainable. Through the use of this process furnace work in shipbuilding can be made less costly and more efficient.

Fire Protection of Piers

Effectual Methods of Overcoming Fire Hazard on Steamship Piers

BY FRANK V. SACKETT

WITH the possible exception of shipbuilding, there is no more important problem in the country today than the proper protection of our war supplies from the danger of fire. Few people in the country realize the vast quantities of supplies that are now congested in our different seaports. When it is remembered that practically the entire output of our industries must necessarily pass through the various seaport terminals, it will be understood that every precaution must be taken to constantly protect them. Some idea of the amount of supplies can be gained from a statement made by Mr. A. H. Smith last March, to the effect that on that particular day 29,200 carloads of goods were being delivered to the North Atlantic seaports. The district of New York alone handles about 50 percent of the foreign commerce of the country, and in the last fiscal year this amounted to over four and a half billion dollars, including gold shipments, for that one port alone.

The safeguarding of these supplies against fire is much more difficult than might at first be supposed. In many cases the owners of piers have appreciated the crisis and taken extra precautions against fires, even adopting suggestions that did not appear to be warranted so as to leave nothing undone. The various authorities have also greatly extended their activity by increasing the number of inspections and rigidly enforcing all regulations, an excellent illustration of this being the order barring the public from access to pier property. Unquestionably this step will lessen, to a considerable degree, the danger from incendiary fires. There is no question of the intention of the owners or authorities to do the right thing to prevent fire, but the conditions are so serious that we can afford to take no chances. While the very concentration of these supplies makes them easier to supervise, it is also a serious matter, because such large quantities are subject to loss from one fire. There is no way at present that these supplies can be separated from each other, on account of the necessity of being near railroad terminals. The entire matter of fire protection of ports should be placed under some experienced authority, with proper facilities for making a careful investigation of the subject, and ample power to enforce any regulations. While there is no doubt that the authorities are doing the best they can at the present time, their authority is limited, and their duties are not always properly co-ordinated. An illustration of this is found in the laws governing the shipments of explosives, which supervise them up to the point where they leave the pier, but as soon as they leave the pier the protection regulations pass into other hands. Of course, this is wrong, as the same safeguards are necessary against fire on boats as at any other point. As a matter of fact, one of the most serious hazards to life and pier property is the possibility of fire on boats carrying explosives of any kind, which was recently demonstrated in the Halifax disaster.

The protection of pier properties involves special

Fig. 1.—View of Brooklyn Pier Equipped with Automatic Sprinklers, Showing Curtain Board Extending Transversely Across the Pier

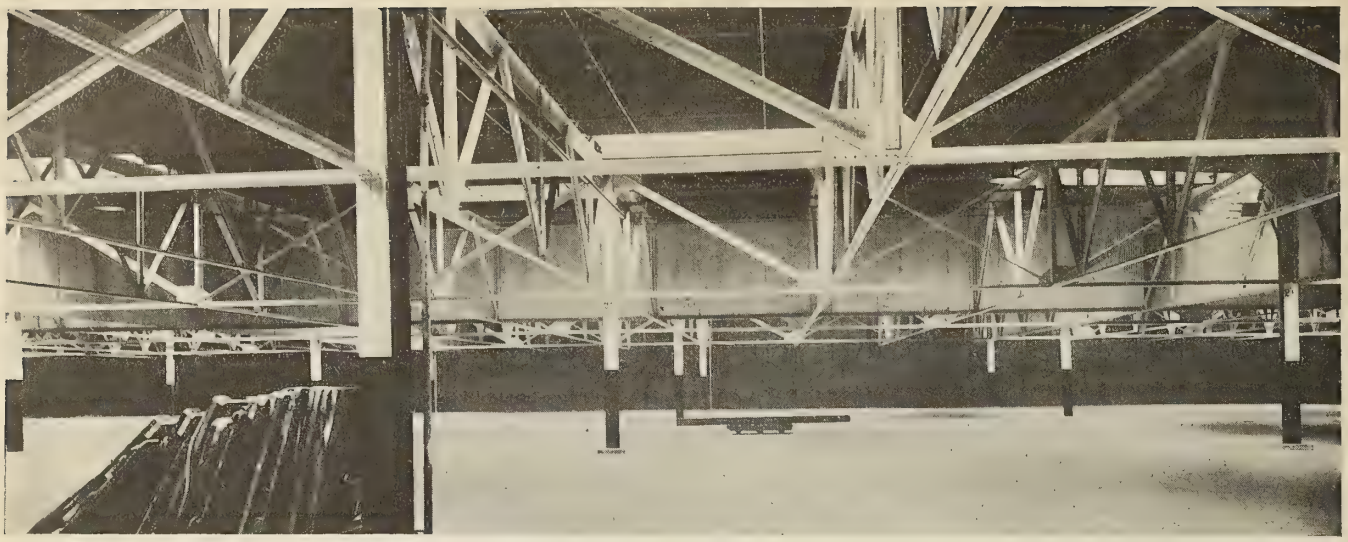


Fig. 2.—View of Brooklyn Pier Equipped with Automatic Sprinklers, Showing Curtain Board Extending Down the Center of the Pier

The curtain boards shown in this and the preceding picture divide the area in the pier shed and help to bank the heat of any fire at the sprinkler heads. A large number of fires on this pier have all been successfully handled by the automatic sprinklers.

hazards which require special attention and constant following up; and on account of the extreme importance of this matter, we outline briefly, in detail, the conditions found on piers.

CONSTRUCTION

Construction varies to a considerable extent, but, in general, tendency of the past few years has been to improve the type of buildings used for this purpose. No doubt good construction would be of material assistance in safeguarding against the danger of fire, but, unfortunately, the present crisis will not permit of sufficient time to change existing construction defects. Frequently we find fire-resistive construction in the more modern property, and a few sprinklered piers. Some are also found with fireproof floors and of slow-burning construction. In general, however, piers consist of one-story corrugated iron buildings, supported on wooden frames and wooden piles. Sometimes they are two stories, but always with high ceilings and large openings in the sides for loading purposes. Almost invariably they connect by unprotected openings with adjoining bulkhead buildings of ordinary construction and considerable size.

One of the worst features of piers is their large area, which is all open and subject to heavy drafts. Very seldom are these areas broken up by dividing walls. Unquestionably some good could be accomplished along these lines. For instance, fire breaks could be installed both above and below pier floors, which would prevent the fire from spreading so rapidly and thus give the fire fighters a chance. Owing to the fact that piers are subject to heavy vibrations and movement, a great many could not be protected with standard fire walls; but fire breaks would help considerably, and might be made of corrugated iron above the floor and heavy timbers below

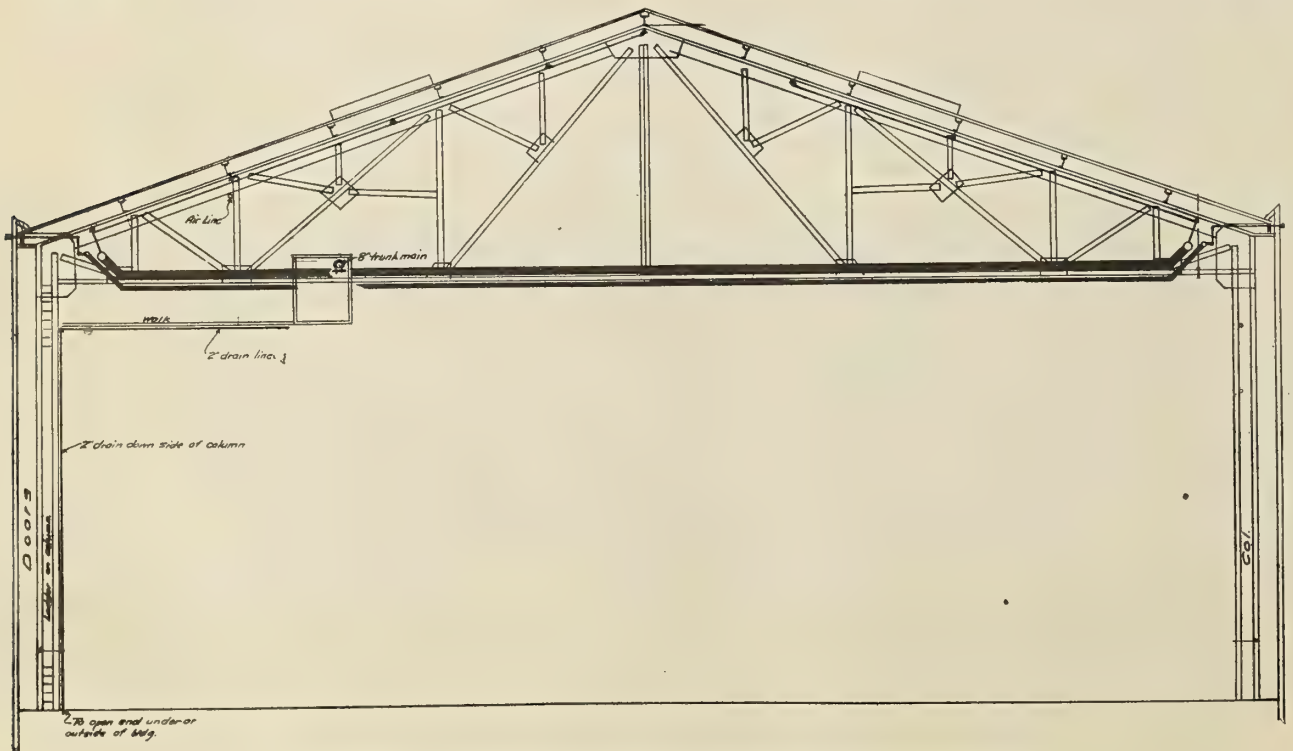


Fig. 3.—Section of Typical Pier Property Equipped with Automatic Sprinklers

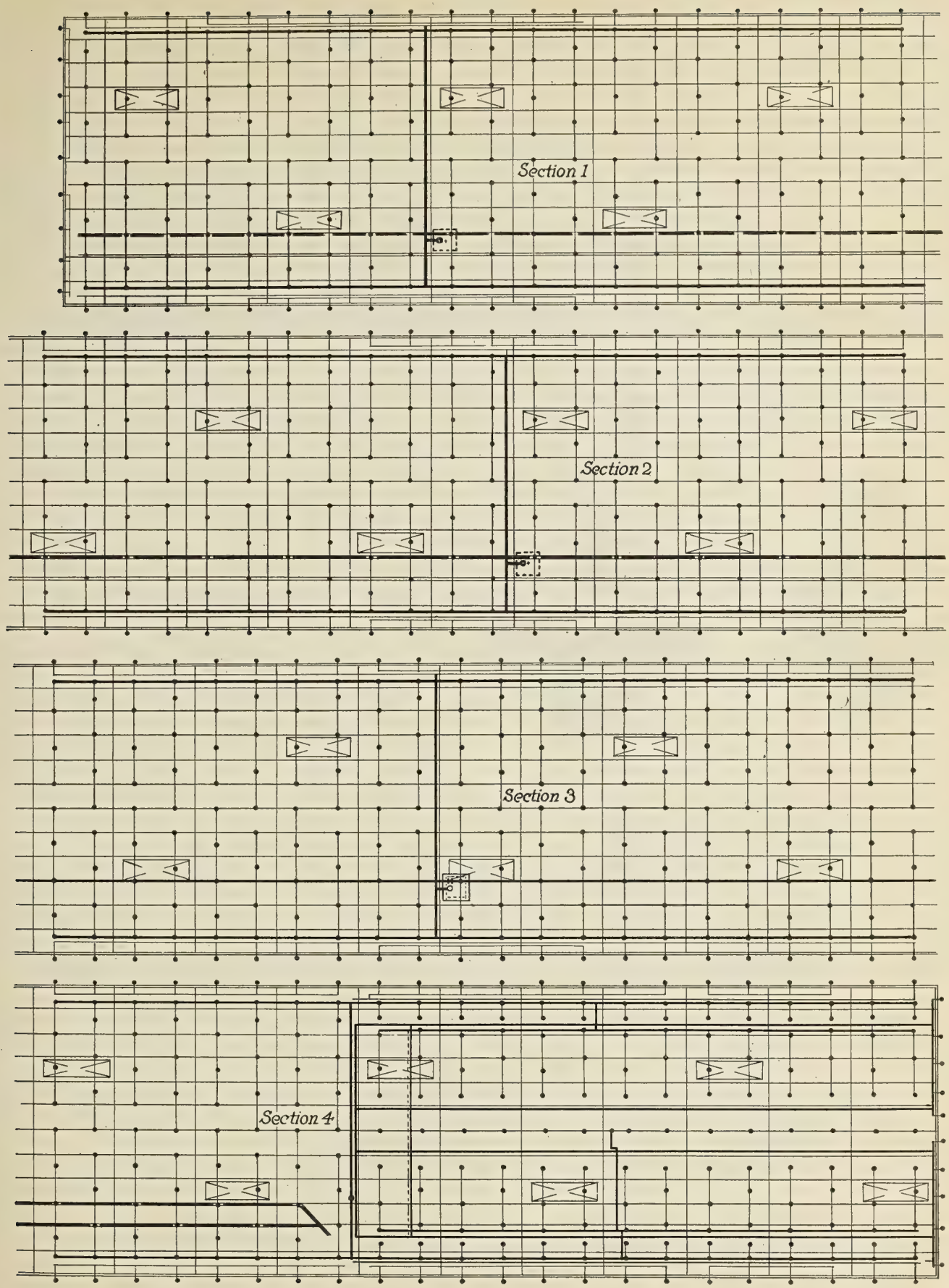


Fig. 4.—The Layout of Sprinkler System in Typical Pier Property. Note the Provisions for Sprinkler Protection against Exposure Fires and for Curtain Boards to Cut Up Ceiling Areas and Allow Heat to Bank at the Sprinkler Heads

the floor—a construction which would not be affected by the movement of the pier. While some objection might be made to this arrangement, on the ground that it would interfere with operations on the pier, it should be noted that piers with dividing walls are being satisfactorily operated.

Accessibility

From the very nature of piers, they are less accessible than ordinary buildings. Their location near railroad terminals or on water fronts means a frequent delay on account of congested traffic conditions. Furthermore, the ordinary building is accessible to fire fighters from all four sides, while piers are accessible only from one side, and that is always the short side. Approach from the water sides may be cut off by barges, blocking the slip, and regulations should be made to keep these slips clear, so that fire boats can approach from all sides.

Occupancy

The handling and storage of all sorts of supplies, from dangerous chemicals to aeroplanes, which must be received in whatever condition they are delivered by the transportation companies, is a dangerous operation. Furthermore, there is a constant change in the kind of material passing through from day to day, and this changing in itself produces a hazard, as elements that may be safe enough in themselves are frequently brought in contact with other elements which may cause them to be dangerous. Undoubtedly, one of the worst features about this miscellaneous stock is the trouble with broken packages and containers, and the constant spilling of the various contents about the pier, where they may cause trouble later on.

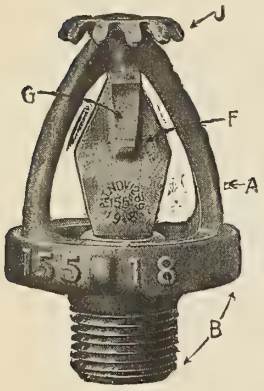


Fig. 5

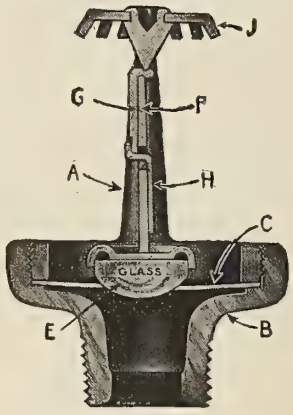


Fig. 6

Efficiency of automatic sprinkler protection depends upon the operation of the automatic heads themselves. Figs. 5 and 6 show details of one of the best-known types of head. The body *B* screws on to the tee in the line pipe. The yoke or frame *A* screws into the body and carries the deflector *J*. Between *A* and *B* is held a flexible diaphragm *C* with a ½-inch hole in the center. Into this hole fits the hemispherical glass valve *E*, held in position by a small metal cap and a strut of three pieces, *F*, *G* and *H*. These three parts are held together by fusible solder. As soon as the temperature reaches 155 degrees F. the disruption of the strut begins, and ultimately takes the form of a rocking motion, one part about the other. During this movement the flexible diaphragm with the full water pressure under its entire area holds tightly against and follows the glass valve until, as the strut finally falls apart, both valve and strut are thrown out into the room. Then a stream of water under full pressure, striking the deflector, is scattered in all directions in a hard-driven rain.

Chief Kenlon, in his book, "Fires and Fire Fighters," describes piers as, "comparable to nothing but horizontal flues, through which flames rush with a lightning-like rapidity, rendering abortive any efforts on the part of the fire department, unless the greatest promptitude is shown by all concerned."

Hazards

The *lighting* and *heating* hazards are about the same as in the ordinary building and apparently are well taken care of, but of course they must be continually followed up.

Smoking: No matter what regulations there are regarding smoking, it is a hard matter to handle. The danger from this source is always present and the only remedy is to keep after the matter and treat offenders severely.

Help: The scarcity of labor has resulted in the employment of undesirable and irresponsible help. It is a case of that or nothing, and certainly results in an increased hazard in handling. These men are not efficient and are not trained in matters of fire protection as well as in ordinary times. There is no remedy for this condition except a careful and continual watching of these men.

Exposures: Piers are subject to exposure fires, not only from adjoining frame structures on land and other piers, but also from vessels alongside, and floating material from other fires in the vicinity. They are much more susceptible to exposure fires than ordinary property because the high winds prevailing on the waterfront carry flying brands greater distances and fan these incipient fires wherever they start. An excellent illustration of this feature was the Jarvis fire, on the New Jersey waterfront, which spread across the river to a pier in New York. The vessels alongside and in the harbor are also hazards, because the employees on board are careless about fire protection matters, and are not under restraint by the pier owners. Frequently, boats containing dangerous contents catch on fire and they may expose several piers in the same harbor.

Fire Protection

Too much emphasis cannot be placed upon the necessity and importance of ample water supply for fighting pier fires, and yet, during this last winter, a large section of the New Jersey waterfront was greatly endangered by low pressure in the city mains. Reliable reports indicate that at the time of the coal shortage and very cold weather the city pressure at many points near pier property was *under ten pounds.*

This danger was somewhat offset by good private supplies, but simply indicates how bad things can get when not properly followed up. The size, location and condition of all mains and outside fire hydrants are matters that must have continual attention or they are liable to fail during an emergency. Instances of this kind have already occurred.

Inside Standpipe and Hose

For instant use with incipient fires, and to hold them until the fire department arrives, proper standpipe and hose connections are essential and are generally provided. It appears, however, that this form of protection is open to some objection not common in other property:

1. Subject to freezing, as shown by many cases that happened last winter.
2. Liable to be used by crews of boats alongside for purposes other than fire and damaged or left out of condition by them.
3. Frequently inaccessible or blocked by piling of goods too near hose racks.
4. Control valves are necessarily located out of reach and when the operator finds the fire too severe he is liable to run without stopping to close the valve, allowing the waste of water when not needed.
5. Condition of piping where salt water is used fre-

quently requires special attention on account of barnacles, pitting, etc. The only remedy for these conditions is constant inspection and frequent tests of the apparatus.

Extinguisher Pails and Casks

The value of this form of protection lies in the fact that everyone knows how to use them, and if used in time they may prevent losses. They must be looked after frequently to see that they are ready for instant use.

Watchmen

This is one form of protection that means much or little, depending entirely upon the watchman himself. In the past, the main trouble has been that men used for such purposes were not competent to fill the position, frequently being pensioners and others that were not physically fit. The importance of having strong, alert young men is becoming more apparent. When it is remembered that every night the entire protection of great values is solely dependent upon their good judgment and faithful efforts in a monotonous job it will be understood that first class men must be employed. It is also advisable to have a watchman's checking system, and he must be thoroughly instructed in detection and fighting of fire.

Fire Alarm

Both city and local fire alarms are desirable. The important thing is to give the alarm promptly, upon the discovery of the fire, as assistance cannot be rendered too soon. For some reason or other, there seems to be more trouble with delayed alarms, in connection with pier fires, than with other classes of property, and too much importance cannot be laid upon the necessity of early alarms for pier fires. Local fire alarm gongs operated from the same box are desirable for the purpose of notifying all employes immediately, and they furnish the best method of drilling them.

Fire Brigade

A well-trained fire brigade is a very great advantage because these men are constantly on hand and available. Their jobs depend upon getting the fire out. Further, on account of their familiarity with the property and the fire-fighting apparatus, they are able to get at the trouble very quickly. They should be under the direction of some experienced head and drilled regularly in their duties. They should know all about the apparatus and what to do in any emergency. They should be men selected carefully for their qualifications along this line; surprise tests should be made by the owners frequently to see whether they are properly responding to alarms.

Automatic Sprinklers

The value of these systems is well known, and where properly maintained there is no question as to their efficiency. Pier conditions require special consideration as follows:

1. They must be dry systems because the piers are not heated.

2. High ceilings and particularly draft conditions make necessary curtain boards to bank the heat at sprinkler heads for high efficiency.

3. Extra heavy water supplies are required because of the large area subject to one fire.

4. Outside sprinklers are sometimes necessary to protect from exposure fires on vessels, etc., that may be alongside of the pier.

5. Sprinkler supervisory service for the purpose of automatically calling in the fire department whenever a fire starts.

6. Proper housing for mains and dry valves to prevent freezing during cold weather.

When there is likelihood of the sprinkler pipes of an automatic sprinkler system being subjected to temperatures below that of the freezing point of water, a system known as the dry pipe system is used. This differs from the ordinary or wet pipe system, in that compressed air instead of water fills the pipes until a sprinkler operates, when the air quickly escapes and water is admitted. In order to thus control the flow of water, dry pipe valves are used. Their function is to exclude water from the sprinkler system until a sprinkler opens. The dry pipe valve, as manufactured by the General Fire Extinguisher Company for Grinnell automatic sprinkler systems, is shown in cross section in Fig. 7, and as it would appear in a sprinkler system in Fig. 8.

Referring to Fig. 7, *A* is the cast iron valve body molded in one piece, *B* is a dished malleable cover closing

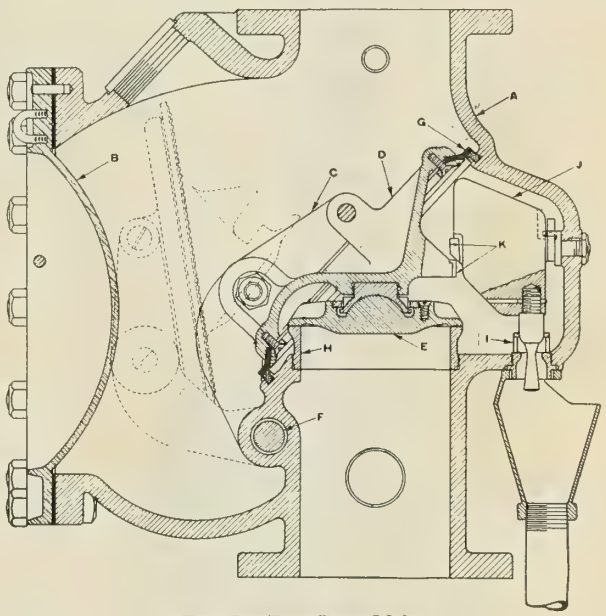


Fig. 7.—Dry Pipe Valve

a handhole conveniently located for setting and cleaning the interior parts. Two forged arms *C*, directly in line with each other in Fig. 7, and therefore appearing as one, cast iron member *D*, to which they are bolted, and bronze water clapper *E*, attached to *D* by means of the self-adjusting hemispherical joint, clearly shown, rotate as one piece about the bronze pin *F* and constitute the only essential moving member of the valve. The air joint is formed by rubber air valve *G* resting on a Babbitt seat, while *H* is the bronze water seat, raised well above the surrounding cast iron. The triangular space between the two seats is the intermediate chamber vented to the atmosphere through drip *I*. Slight opening of the clapper permits the latch weight *J* to fall, closing *I* and preventing reseating of the valve by engaging surfaces at *K*.

The operation of the valve is as follows: When the escape of air through an opened sprinkler has caused the air pressure on the upper side of the rubber air valve *G* to fall to about one-sixth of the water pressure acting on the under side of the water valve *E*, the clapper rotates through a small arc from its shut position, shown in full lines, to its open position, shown dotted, drip *I* being closed by the falling of latch weight *J*. This opening action occurs in a smooth and quiet manner without shock

or jar at any service pressure and is completely accomplished down to about five pounds per square inch water pressure. Once opened, the clapper cannot be reseated except manually after the removal of the hand hole cover *B*. In view of this it is evident that the main function of weight *J* is to close the drip *I*, it being probable that no service conditions will be encountered that would require its functioning as a latch.

The valve will open when the air pressure has fallen to about one-sixth the water pressure, or, as it is usually expressed, it has a ratio of six to one. An inspection of Fig. 7 shows that the air valve is but slightly more than three times the area of the water valve. The arrangement of the two valves is such, however, with respect to the axis of rotation *F* that the air pressure has the advantage of a leverage almost twice as great as that available for the water pressure, hence the ratio of pressures of six to one is obtained.

Turning to Fig. 8, the arrangement of the auxiliary piping and valves is seen. The use of these can best be

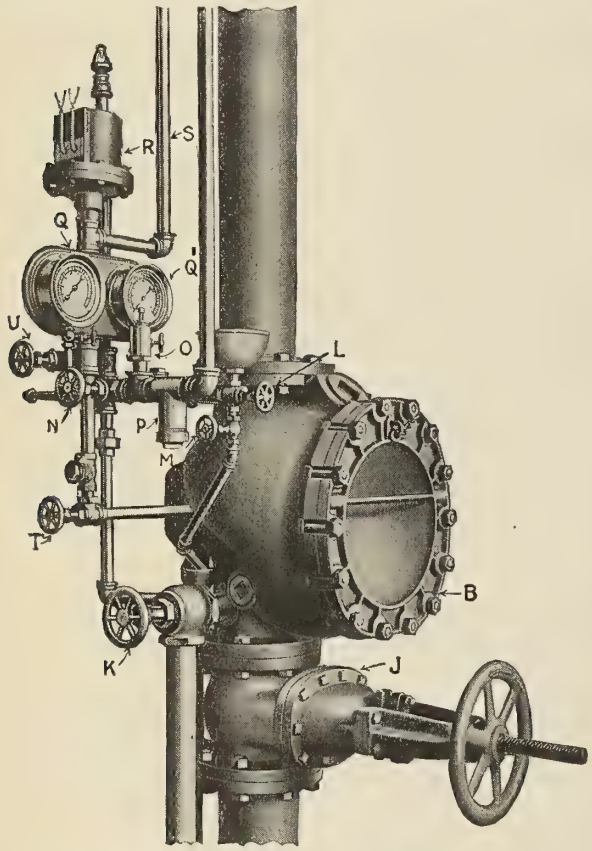


Fig. 8.—Dry Pipe Valve in Place in Sprinkler System

explained by assuming that the dry pipe valve has operated to extinguish a fire, and that we are called upon to put it back into service. Valve *T* is found open, and water flowing past it from the intermediate chamber causes operation of the electric alarm by means of circuit closer *R*, and continuing through *S* also operates the water motor gong on the outside of the building. As we know of the existence of the fire, these alarms have served their purpose, so we close valve *T*. After making sure that the fire has been entirely extinguished, gate valve *J* is closed and *K* opened, thus draining the sprinkler pipes of water. Hand-hole cover *B* is next removed. The rubber air valve, its Babbitt seat, the bronze water valve and its bronze seat are then carefully wiped and the clapper pushed forward until it falls into place. Next we raise the latch weight by means of the projection that extends through the drip valve opening as shown on Fig. 7 and then replace *B*, which is held on a short stud, so that both hands are free for inserting and tightening the bolts. This done, valve *L* is opened and water poured into the priming cup above it, the surplus being drained off through *M*. With *L* and *M* closed, *N* is opened until gage *Q* indicates that we have sufficient air pressure. Should we be careless and permit too much air to enter the system safety valve *O* will operate. Sediment strainer *P* prevents grit and scale from entering the dry pipe valve. After making sure that *T* is open and *K*, *L*, *M*, *N* and *U* closed, we open gate *J*, thus placing the system in readiness for the performance of its duty when next called upon. The water pressure is indicated by gage *Q*; valve *U* is a test connection which when opened permits the flow of water to the circuit closer and the water motor alarm for purposes of trial.

Monitor Nozzles

There is no doubt that in certain cases these nozzles can deliver large amounts of water that may be necessary for exposure fires, but there is some difference of opinion as to their value. The fact that they throw great quantities of water has some disadvantage, as there may be considerable waste. It is stated that on one pier property in the South the loss of pressure from the use of these nozzles resulted in the fire getting away from the fire department and destroying the pier. This undoubtedly was due to the improper handling of the nozzles, but where fire boats or tugs equipped with hose can be relied on to handle exposure fires they are more satisfactory.

As an example of the good work done along fire protection lines by pier owners, we mention the Pennsylvania Railroad Company, which operates piers at various points. In the first place, Mr. F. H. Newbern, superintendent of their insurance department, considers fire protection a regular business and handles such matters, through a picked corps of assistants, in a systematic, businesslike manner, paying particular attention to the constant following up of all details which are liable to be neglected. Mr. Newbern works along the well-proven plan that "the best time to fight a fire is several years before it happens." He believes in the careful training of the men that are working on the property, and insists that they all know the danger of fire and also how to fight the fire with the apparatus which is provided. "Keep things clear," is the first general order, and it is carried out, no matter how many brooms are required to sweep the rubbish, waste, etc., where it can do no harm. "Call the Fire Department" is the second order, and this is done before any move is made to fight the fire. They don't believe in taking any chances with fire that might get away from them. "Give it water" is the next order, and they believe in plenty of water being right handy. In Jersey City they carry a pressure on their private supply of about 100 pounds and can supply twelve streams with their three pumping stations.

Incidentally, their engines are also equipped with hose for fire-extinguishing purposes. All their tugs are ready for fire duty, and act immediately when the alarm is given. Their fire brigade is composed of selected men acting under orders of an experienced chief. They are regularly drilled in their duties and the actual handling of all fire equipments. A fire marshal, with no other duties, has direct supervision over all matters of fire protection, and makes regular and surprise tests to see if the men can be caught off their guard. Inspections are made of their own premises and that of adjoining property. Any improvements that can be noted are im-

mediately carried out. One of the precautions taken is to see that small boats are kept ready with necessary apparatus for fighting fires that may occur under the pier.

On account of the danger of incendiary fires, they have not only added extra help and increased the vigilance in watching workers on the pier, but have also provided extra lighting facilities and flood lights for illuminating the outside of the property at night. Care is taken to separate inflammable material from other goods and isolate same as far as possible on open piers. The alarm system is tested daily and is always used to notify the employes in any emergency. The keynote of the successful record of the Pennsylvania is in the fact that they recognize plain, common, everyday *carelessness* as the cause of most fires and realize that constant and continual vigilance is the only way to combat this enemy. "Keep clean," "Preparedness," with "Plenty of Water" is certainly a good remedy for any buildings subject to fire.

As to the chances of fire on piers, it may be noted that during 1916 the total loss of pier buildings (not including contents) was under $600,000 (£123,000) for the entire country, according to the National Board of Fire Underwriters. Last year's figures are not as yet available, but we have only to cite the following fires to be convinced that the losses on this class of property are piling up rapidly,

Atlantic Coast Railway, Charleston, S. C.	$ 22,000	(£ 4,520)
Lehigh Valley R. R., Fairhaven, N. Y.	25,000	(£ 5,140)
Panama Railway, New York City	20,000	(£ 4,100)
Pier 26, Brooklyn, N. Y.	1,000,000	(£ 205,000)
Saxon Motor Co., Detroit, Mich.	50,000	(£ 10,250)
Baltimore & Ohio Terminal, Baltimore (Estimated)	5,000,000	(£1,025,000)

and the present year has also started out badly, as illustrated by the Port of Newark fire.

Considering the serious hazards in pier property, it is a surprising fact that only a comparatively few piers have been protected with automatic sprinklers. For example, we find only one or two standard sprinkler equipments out of some hundred and fifty piers in Manhattan. Brooklyn has a better showing, with eighteen sprinklers, and New Jersey with about a half dozen. In the entire country, there are only about sixty piers safeguarded with sprinklers.

The probable reason for such a low percentage of sprinklered piers is the fact that these properties are largely owned by railroads, and they have been so hampered by different regulations in the past ten years that they were unable to obtain the necessary funds for these purposes, although the conditions are so severe as to warrant this expenditure, even in ordinary times.

We find that it is practically the unanimous opinion of all the fire protection engineers that sprinkler systems afford the best possible protection for this class of property, and many of them believe it to be the only satisfactory form for their particular conditions.

Mr. E. P. Boone, of the New York Fire Insurance Exchange, has had more experience with sprinklered piers than anyone else in the country, and he is an enthusiastic believer in sprinkler systems for piers. His experience covers a number of actual fires which have resulted in only nominal loss to the property on account of the quick action of the sprinklers. He mentions one case where fire opened some twelve sprinkler heads which extinguished the fire so promptly that there was no interruption to business. Although the smoke was thick, the drivers continued to operate their motor trucks, loading and unloading as though nothing had happened.

Figs. 3 and 4 give a good idea of the way Mr. Boone adapts sprinkler protection to the special conditions existing on a pier. Large open areas are broken into sections by special curtain boards coming down from the ceiling, which bank the heat at the sprinkler head in spite of the drafty conditions. Note that some curtain boards are parallel with the pier and others intersect them at right angles, running across the pier together, forming large pockets for the heat to rise in. This construction is rather unusual and is made necessary on account of the extreme width of the pier. One view also indicates the great length of the pier. These views show one of a group of sprinklered piers owned by the Bush Terminal Company, whose property was recently taken over by the Government.

The following piers are protected with sprinklers, and located in the New York district:

Baltimore & Ohio Railroad Company, Pier No. 66.
Lehigh Valley Railroad Company, Pier No. 5.
W. R. Grace & Company, Pier No. 33.
Barber & Company, Pier No. 36.
New York Dock Company, Pier No. 39.
New York Dock Company, Pier No. 40.
American Manufacturing Co., Milton Street Pier.
American Sugar Refining Company, 3d Street Pier.
United States Steel Products Company, 29th Street pier.
Pier, Foot of 35th Street, formerly Luckenbach Steamship Company.
Norwegian American Line, 30th Street Pier.
Hamburg American Steamship Company, Pier No. 134.

Instances of other piers that are sprinklered, in different cities, are:

Commonwealth Pier, Boston, Mass.
State Pier, Providence, R. I.
Delaware, Lackawanna & Western Railroad, Hoboken, N. J.
Mystic Wharf Dock, Charleston, Mass.
Norwich Line Docks, New London, Conn.
San Pedro Docks, California.
White Dulany, Seattle, Wash.
Port of New Orleans, New Orleans, La.

At this time there is nothing of more importance than the conservation of all our resources and efforts. No amount of money could replace the loss of our war supplies and terminal facilities. A fire on one of these piers would badly interfere with our operations here, and might easily affect our war program abroad. The absolute protection of this property is most vital and it has not received the attention its importance deserves.

"Everybody's business is nobody's business," and we firmly believe that serious trouble will result unless the entire matter is handled in a businesslike manner by some high authority with broad experience in this line. We submit:

1. That there should be no question as to the reliability of all water supplies involved, either public or private.
2. That lighters and boats exposing piers should be compelled to conform to established fire protection practice and not be permitted to endanger this property by using kerosene lamps, cooking stoves, etc.
3. That dangerous chemicals, oils and highly inflammable materials should be segregated and kept separate from other supplies.
4. That barges and boats should not be permitted to block up slips, preventing access to the sides of piers.
5. That extra large areas should be divided by section walls or fire breaks.
6. That explosives, or explosive materials, should not be permitted near the important terminals.
7. That bulkhead buildings should be cut off from piers, wherever possible.

8. That sprinkler protection should be provided where conditions appear most serious.

9. That good reliable watchmen should be employed at night to properly safeguard the contents.

10. That all dirt, waste and rubbish should be immediately removed and the premises kept scrupulously clean.

11. That, wherever lacking, all necessary fire-fighting apparatus should be provided and constantly tested and inspected.

12. That there should be a uniform practice established for handling all these matters, and particularly seeing that they are followed up from day to day.

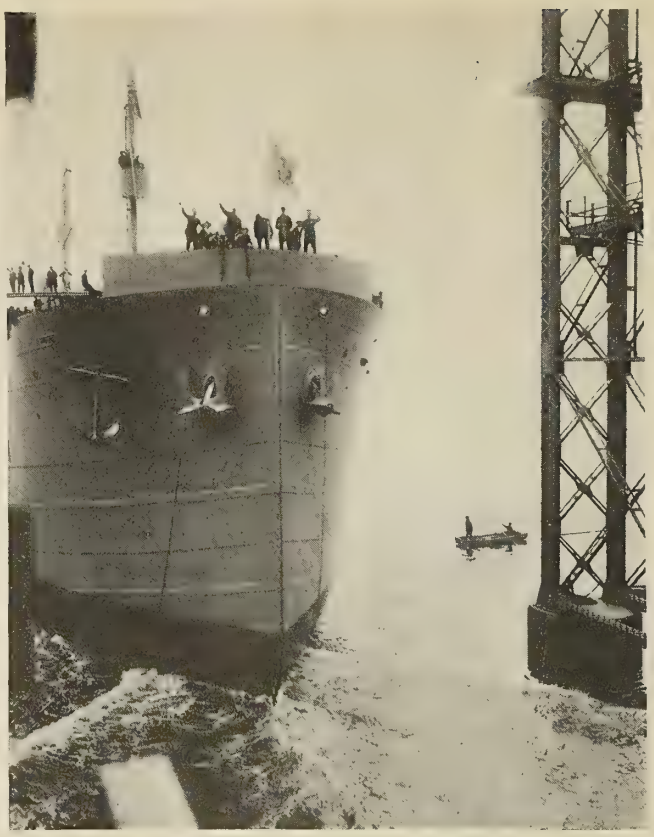
In our opinion the desired results can only be accomplished in one way: the Government must create a special central authority with necessary experts to make a complete study of the entire situation in all our seaports and then place the responsibility of handling and following up such matters in this one central authority. It must be more than an advisory body, and should be composed of men with practical experience in such matters, and capable of enforcing the necessary regulations. This step is not only justified, as a matter of business expediency, but is, in reality, a matter of military necessity.

These supplies on our piers are the real sinews of war. They are the things we bought with money from Liberty Bonds and are all finished, packed and ready to go where they can help win the war. They must be well safeguarded against fire at any cost.

Five Thousand-Ton Collier Built in Thirty-seven Days

A world's record for speed in shipbuilding has been established by the New York Shipbuilding Corporation, Camden, N. J., by delivering the 5,000-ton collier *Tuckahoe* in thirty-seven days after laying the keel. The keel was laid on April 8. Three days later all the bottom plating was laid, the inner bottom floors in place and the tank top plating laid ready for the bulkheads.

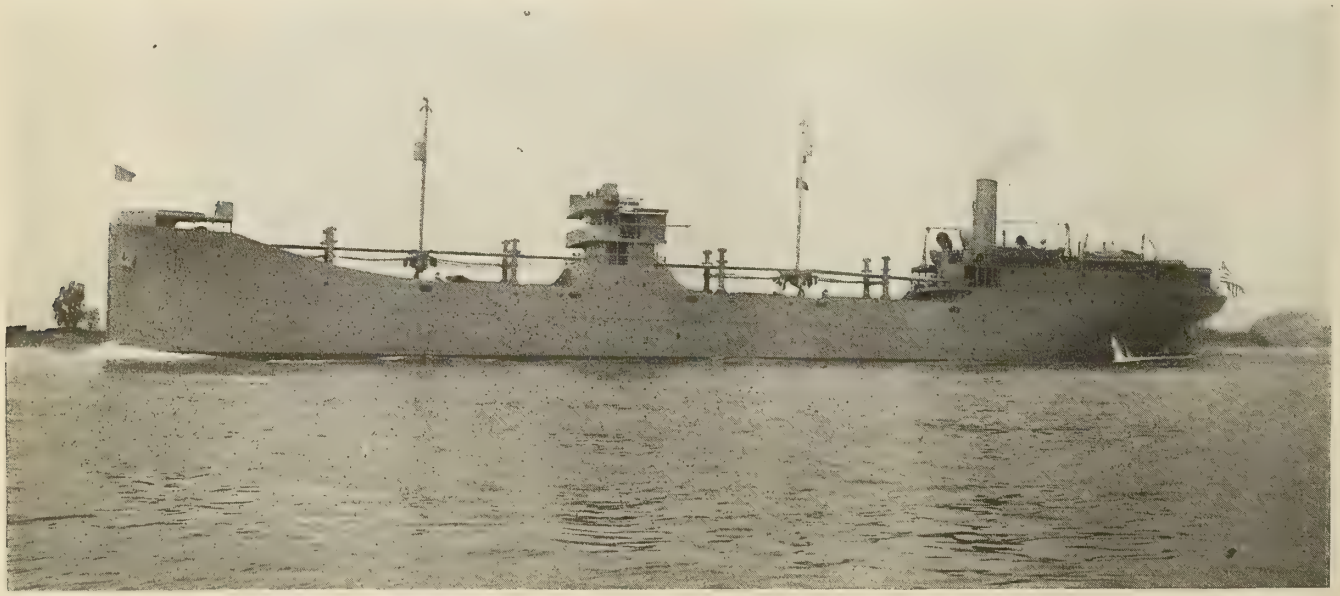
The vessel was launched 95 percent complete on May 5, just 27 days, 3 hours and 5 minutes from the laying of the keel. On May 16, thirty-seven days after the keel was laid, the vessel was turned over to the Government.



Launching the *Tuckahoe* Twenty-seven Days After Laying the Keel

The *Tuckahoe* is a collier of 5,500 deadweight tons, 332 feet 6 inches long overall, 49 feet 3 inches beam and 27 feet 6 inches molded depth. She is a sister ship of the S. S. *Freeman* described in our February issue.

Immediately after the *Tuckahoe* had finished her trial runs, she was docked at the Curtis Bay pier at Baltimore, where, in the record time of two hours, a cargo of 4,992 tons of coal was taken on board. Fifty-five minutes later the cargo was trimmed and the vessel was on her way to New England ports.



S. S. *Tuckahoe*, Built by New York Shipbuilding Corporation, Camden, N. J., in Thirty-seven Days, Establishing a World's Record for Speed in Shipbuilding

Welding Ship's Parts Together

Electric Welding Committee of Emergency Fleet Corporation Developing Methods of Welding Ships with Electric Arc

BY JAMES G. DUDLEY*

WITH the opening of a shipbuilding era in the United States, the native Yankee genius of adaptability (not being a shipbuilding nation) naturally turned to an investigation of methods of fabricating steel for the wholesale "manufacture" of ships other than those conventionally employed for the "building" of a ship. The method logically suggesting itself to skilled inventors, technicians and mechanics was to employ the "welding" means which are fast revolutionizing railroad repairs and fabrication and which have made possible countless modern machines and processes.

The "welding" methods now commercially available for joining together the steel members of a given structure are:

1. "Smith" Welding:
   - (*a*) pure.
   - (*b*) resistance: (1) butt method; (2) spot method; (3) seam method.
   - (*c*) water gas.
2. "Fusion" Welding:
   - (*a*) Flame blowpipe.
     - (1) oxy-acetylene.
     - (2) oxy-hydrogen.
     - (3) oxy-coal gas.
     - (4) oxy-carbohydrogen.
     - (5) oxy-thermalene.
     - (6) "Blau" gas.
   - (*b*) "Thermit" Welding.
   - (*c*) Carbon arc.
   - (*d*) Metal arc.
     - (1) bare electrode.
     - (2) coated electrode.
       - (*a*) gaseous flux process.
       - (*b*) liquid flux process.

Fig. 1.—Welding a Skylight on Board Ship

It is not the purpose to here present an exhaustive technical analysis of the many and varied phases of welding, but rather to outline the status of this art, with reference to its applicability to, and adoption in, shipbuilding. Before considering the application of welding strictly to marine work, it is well to review its use in railway service.

At the outset it will be understood that there will be eliminated from this review all employment of: (1) "Smith" welding and (2) all "fusion" welding save the "metal arc" processes. For more than five years past the railways of the United States have been employing metallic electrode welding in largely increasing amount and with astonishing technical and economic gains in securing practically leakless conditions of the tubes and furnace sheets of the locomotive boilers. While electric welding has not—so far as known—supplanted riveting in this particular service, yet railway experts admit that but for its employment such giants as the Mallet-compound locomotive could scarce be kept on the rails. For more than seven years the Chicago, Burlington & Quincy Railroad has been successfully operating a fifty-ton gondola freight car completely fabricated by means of electric welding. The Rock Island System is claimed by its electrical engineer (Mr. Wanamaker) to be saving over all other methods more than $200,000 (£41,000) annually in repairs and fabrication by the use of electric welding.

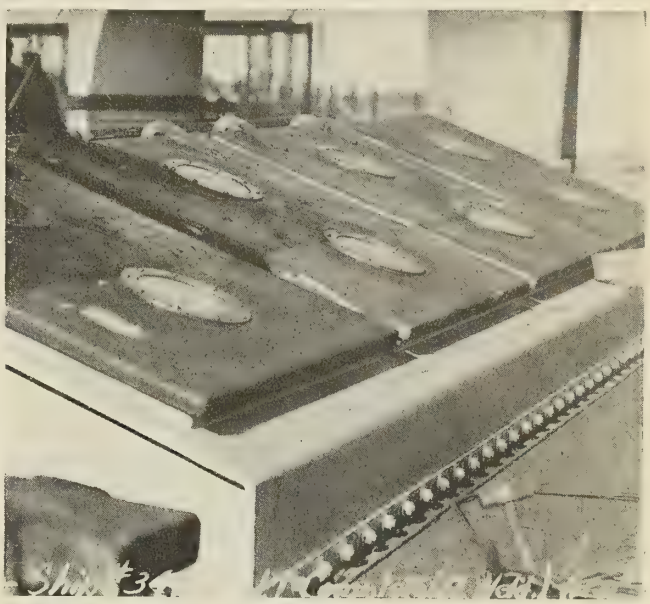


Fig. 2.—Skylight Completely Welded

"When completely equipped," states Mr. Wanamaker, "electric welding will effect savings of more than $1,000,000 (£205,000) annually."

The technical literature of railways and welding demonstrates beyond successful controversion that jointures of more than 100 percent efficiency can be readily and commercially secured by electric welding means. Even the truly remarkable results secured under the punishing

* Research and Experimental Engineer, Chester Shipbuilding Company, Ltd., Philadelphia, Pa.

conditions of steam locomotive service have not as yet overcome the friction and inertia of "standard practice" in so far as the design and fabrication of a complete locomotive is concerned, but eventually the insurance and inspection interests must voluntarily "approve," or be compelled by the march of events to "permit," the fullest possible use of electric welding in this field of transportation.

Passing to marine practice, it is more or less common knowledge in nautical circles that electric welding has been successfully and economically employed for many years past in many ports of many countries in repairing of parts of ships which otherwise must have been tied up for costly periods. The urge of war conditions has for several years past stirred the inventive and progressive genius, not only of foreign nautical experts to seek improved methods of ship fabrication, but has roused native Yankee "landlubber" skill to do likewise. For upwards of two years considerable welding work on ship's plates and parts has been carried out under working conditions, not only by the British Admiralty in England, but by private interests in Newburgh, N. Y., and Chester, Pa., yards.

As a result of certain newspaper publicity given to the subject, as a result of an address by the author before the Philadelphia Builders' Exchange, in December, the merits of "melting ships together" came to the attention of Secretary Franklin K. Lane, of the Department of the Interior, who later brought about official action in the creation by the Emergency Fleet Corporation of an Electric Welding Committee. This Committee has held a number

Fig. 3.—Filling Holes in Reverse Angles by Electric Welding

of organization meetings and now represents a large, growing and representative personnel of nautical as well as "landlubber" technicians, under the able chairmanship of Prof. C. A. Adams, of the Massachusetts Institute of Technology, with Mr. E. A. Stevens, Jr. (late of the United States Shipping Board staff) as secretary.

The Emergency Fleet Corporation has already authorized the building, at the Newark Yard of the Submarine Boat Corporation, of an experimental fifty-foot section of a 9,000-ton ship completely electric welded. In carrying out of this particular work, every known phase,

Fig. 4.—Section Model of Electric Welded Keel

apparatus and process will be given ample opportunity to prove its claims for consideration, and, in addition, the special skill and genius of proven or potential inventors will be given a chance to demonstrate their particular concepts.

Further steps have been taken to start a training department to create a reservoir of skilled welders against the inevitable demand, as soon as the requisite Governmental and Classification Societies' "approval" has been obtained to actually construct vessels or parts thereof by "melting" instead of "riveting." The unanimous conviction and expressed programme of the Electric Welding Committee augurs greatly enhanced speed in the "manufacture" of our ships, especially since expert judgment conservatively estimates that: "Four welded ships can be built for the cost of three riveted ships, and one which is 'melted together' will require but half the elapsed time for complete fabrication."

The British Admiralty have by this time launched a cross-channel barge of some 200 tons deadweight, completely electric welded.

Steps have just been consummated between the Emergency Fleet Corporation and the Welding Committee looking to the immediate preparation of designs "of a 7,500-ton electrically welded merchant ship of a standard construction, with only such changes as do not involve serious modification of the materials on order"; and "of a completely welded ship designed particularly to take advantage of electric welding methods to the maximum degree"; and "of a shipyard for the construction of only such electrically welded ships."

OIL SHALES RESERVED FOR THE NAVY.—In the annual report of the director of the Geological Survey, Department of the Interior, just made public, attention is called to the creation of two naval oil reserves in Colorado and Utah. The Survey has been investigating the oil shales of the United States that give the most promise of yielding a commercial supply of oil, and has explored large areas in Colorado and Utah that contain immense deposits of such shales, some of which carry 30 to 50 gallons of oil to the ton. This potential resource is estimated by the Survey in terms of billions of barrels of oil, which, it is believed, can be economically extracted from the shales, possibly in competition with the petroleum at present prices. It is therefore of special interest to note that during the last year two oil-shale reserves were created for the use of the navy, one of 45,440 acres in Colorado, and one of 86,584 acres in Utah.

General classification of oil-shale land was continued by the Survey during the year, the work covering large areas. Geologic examination of the oil-shale region of the West has shown that the oil shales in Utah and Colorado contain enormous quantities of petroleum. They also contain a considerable percentage of nitrogen, aggregating a vast supply, which can be recovered as a by-product in the refining of the shale and used either as a fertilizer or in the manufacture of explosives.—*U. S. Geological Survey Press Bulletin, No. 349, December,* 1917.

Training Shipyard Workers by Emergency Fleet Corporation Methods

(*Concluded from page* 328.)

instructors of wood shipbuilding. An expert is employed in the training center for the purpose of determining exactly how much of the new trade shall be given to the conversion man to fit him out as an instructor of the particular shipyard trade.

The most encouraging feature in connection with the establishment of a training center in the shipyard is probably the reduction of labor turnover, together with the fact that a green man is much more likely to apply for a position in a shipyard where he knows that a training department exists specially to train him.

The Emergency Fleet Corporation makes an allowance to the shipyard of one dollar per day for each man trained in a training department, fifty percent of which goes to the man if he remains in the yard *seventy-eight days.* This alone tends to hold the man.

There is a certain process of thought and feeling which the new man usually passes through in tackling a new job. The first is that of being out of place, of strangeness of surroundings; the second is that of adjustment; the third is a comsummation which determines whether he shall stay or quit. The instructors trained by the Emergency Fleet Corporation are taught to keep a sharp lookout for these processes of thought in the new man. By a little effort the instructor can eliminate the feeling of strangeness. Care in choosing the surroundings and in instructing the new man will greatly help him to adjust himself. The determination as to whether a man shall stay or quit is largely a matter of interest and depends on how well he can do the new job and the consciousness that when he is turned over to the production department he can at least "hold up his own end" as well as the other fellow.

These considerations and the elimination of high overhead costs caused by the old methods of training, spoiled work, wasted time by the learner, time spent in teaching by the tradesman, etc., probably make the training of new men by a trained instructor whose job it is to do nothing but instruct, the cheapest method that has yet been evolved for the training of shipyard workers.

[NOTE.—Correspondence on the subject of the training of instructors is invited by the Emergency Fleet Corporation; communications should be sent to Mr. E. E. McNary, director of training, Emergency Fleet Corporation, 136 South Sixteenth street, Philadelphia, Pa.]

Full-Powered Motorship Alabama, of 3,600 Tons D. W., Completed on Pacific Coast

The Alaska Pacific Construction Company, Seattle, Wash., has recently built a full-powered motorship designed by E. B. Schock, naval architect, Seattle, which is

Wooden Motorship *Alabama* on the Ways at Yard of Alaska Pacific Construction Company

270 feet 6 inches long overall, 256 feet 6 inches on the waterline, 46 feet beam and 26 feet 6 inches molded depth, with a deadweight carrying capacity of 3,600 tons. The vessel is of the full two-deck type freighter, with machinery aft and a full open hold for the carrying of lumber. She is built throughout of Douglas fir and was given highest class rating by the Bureau Veritas.

Propulsion is by twin screws actuated by six-cylinder, 625 indicated horsepower McIntosh-Seymour Diesel engines. There is a fuel capacity for a 9,000-mile cruising radius. Auxiliary power for winches, etc., are supplied by a Y-type, 75-horsepower, two-cylinder Fairbanks-Morse stationary oil engine, which also drives a generator for furnishing electricity for heating, as well as for the winches and windlass.

The cargo is handled through two large hatches, 16 feet by 24 feet, fitted with four cargo booms, each 55 feet long. The vessel was launched on April 24 and christened the *Alabama.*

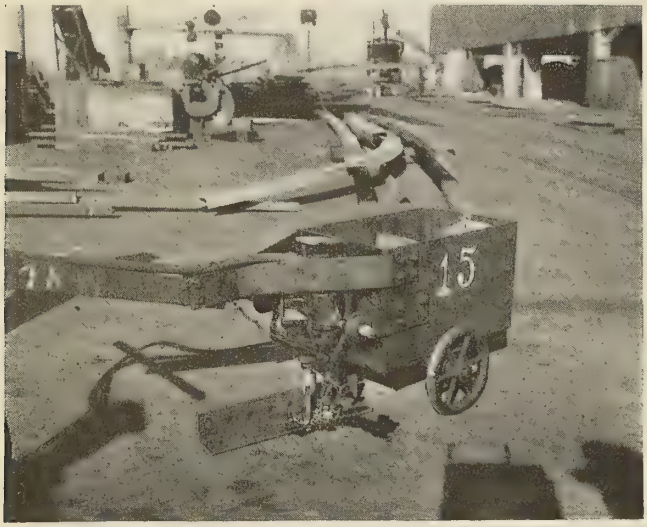
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Pneumatic Drill Adapted as a Portable Countersinking Machine

The accompanying illustrations show very clearly the way in which a No. 1-B "Little David" drill has been



Improvised Portable Countersinking Machine

rigged up by the Hanlon Drydock and Shipbuilding Company, Oakland, California, for service as a portable countersinking machine. The drill has been fastened to two metal supports bolted to the sides of an iron box 16 inches wide, 24 inches long and 16 inches high, provided with a suitable stop for the feed screw. The rig is fitted with a 6-foot handle and mounted on two wheels. Sufficient weight is placed on the box to give the outfit proper stability when in operation. An air hose is connected and a valve placed in the line for use instead of the usual drill throttle. A second hose is provided to feed water for cooling the countersink. Mr. Hiefield, the superintendent, is authority for the statement that this rig will do from 75 to 100 percent more work than the stationary wall countersinkers.

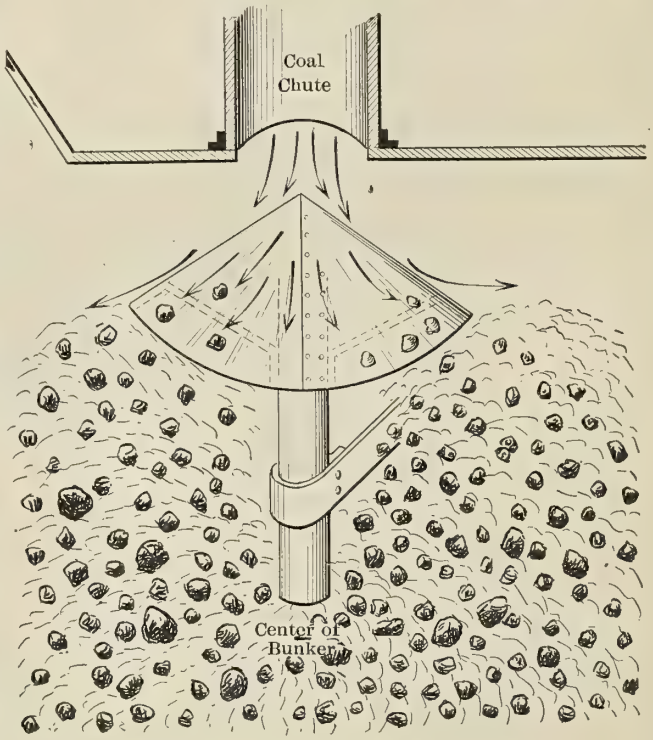
Countersinking Machine in Operation

An outfit of this kind can be easily constructed in any shop and represents but a moderate investment. A suggested modification is that the box be partitioned through the center and that counterweights be carried in the compartment farthest from the drill; and the other half of the box be used as a tank to carry water for cooling the countersink. This would obviate the necessity of a double hose connections.

New York. H. L. Hicks.

Bunker Coal Spreader

Perhaps some of the naval architects or ship designers who cast their optics upon this little affair will laugh and snicker and wonder what fool thought of such an idea,



Sketch of Device for Spreading Coal in Bunker

but nevertheless I can vouch for its practicability as a labor saver in stowing bunkers of a certain vessel. The sketch gives the idea of how the thing works.

On the steamer ——— we had three 100-ton bunkers with their coaling trunks or chutes located right in the center. When coaling ship, the coal would shoot merrily into these bunkers until there would be formed a conical pile right up to the chute, which would then choke up.

The firemen and coal heavers would then be busy every minute stowing from the chute to the corners and sides. From the time the chutes choked till the bunker would be stowed full, 40 tons had to be handled in each bunker.

One day the engineer in charge of the firerooms and coal bunkers hit upon the scheme of making a stout steel, conical-shaped spreader to be installed directly under the center of the chute with plenty of clearance to prevent its blocking by large lumps of coal. He obtained permission from the chief to make one and try it out.

Procuring a spare piece of ⅝-inch boiler plate and the boiler maker's help he got one rigged up, and when the next coaling ship came around he anxiously awaited the results.

It worked quite well, but did not fully come up to expectations. It gave a clear run of 85 tons—25 more tons than when no spreader was used. The bottom diameter of the cone was 4½ feet; the diameter of the coal chute was 2 feet 6 inches. The coal had to drop through 20 feet to the chute, and when it hit the spreader it would shoot clear to the corners of the bunker; it also broke up a large percentage of the lumps. C. H. WILLEY.

Bushing Kinks

There are hundreds of bushings used in the machinery on board ship, pump rocker arms, reach rods, governor spindles, valve stem brackets or guides, ice machinery rods, etc., and these are always calling for attention, so these

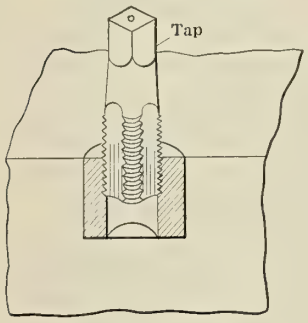


Fig. 1

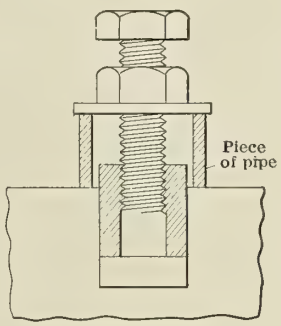


Fig. 2

few kinks that the writer has picked up in his time may be of some benefit to others.

For removing a wornout bushing that is accessible from one side only, the scheme shown in Figs. 1 and 2 is used. When the bushing is small and can be threaded, the tap is used to cut half a dozen good threads, then a bit of pipe, a bolt, nut and washer are used, as in Fig. 2, to draw out the bushing. When the bushing is too large for a tap and is worn out so that it is of no further use, it is cut out with a round nose grooving chisel as in Fig. 3.

When you meet up with flanged bushings installed as shown in the sketch, Fig. 4, a very simple but excellent way to drive them out is to make the two tools shown in Figs. 5 and 6. A round piece of stock that is of the same diameter as the hole in the bushing is all that is needed.

Grind one piece into a wedge at one end, as in Fig. 5, and with a hack saw split one end of the other piece.

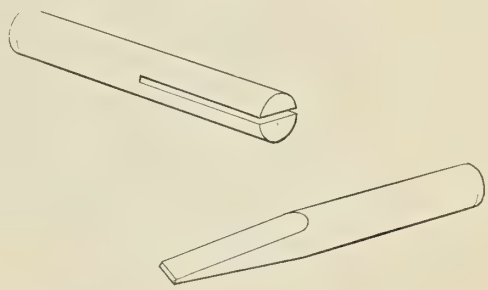


Fig. 6 Fig. 5

Enter the split piece through one bushing, and while holding it enter the wedge piece in the other bushing by forcing the wedge into the split; that piece is opened out as indicated in Fig. 4, so that the ends bear against the inside edge of the bushing, which can then be driven out.

For forcing small bushing into rods, etc., the bench vise can be very easily used to good advantage, as shown in Fig. 7. When one uses a vise for this purpose the screw of it should be well oiled; it should also be borne in mind that undue leverage should be avoided. A short piece of pipe, say 1 foot, is sufficient to distort a vise screw when used on the handle with brute strength and lack of judgment.

Where long bushings are to be installed, such as shown in Fig. 8, a long, threaded bolt nut and suitable washers

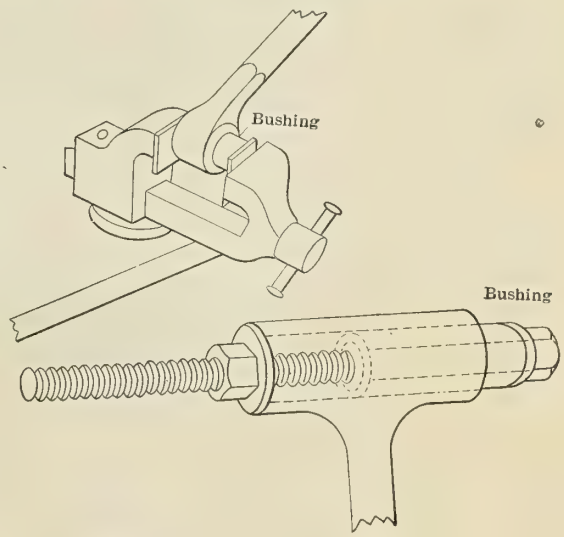


Fig. 7 Fig. 8

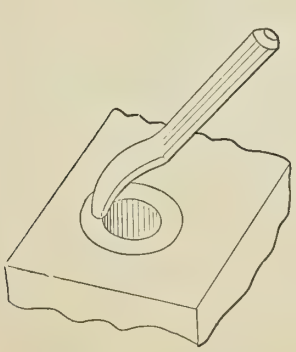


Fig. 3

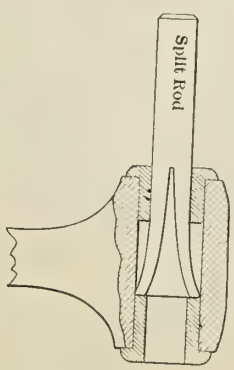


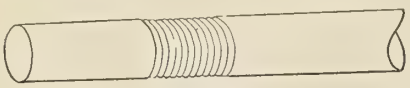
Fig. 4

answer the purpose and do a better job than driving in with a hammer and block of wood, for the bushing will go in square.

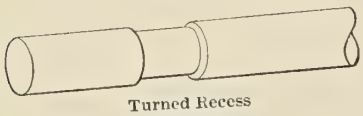
Figs. 10, 11, 12 and 13 show how a loose pulley on a countershaft in the ship's machine shop was bushed. The shaft had become worn and scored so that it was really necessary to turn it. The sketches in series are self-explanatory. The shaft was recessed; the least amount was taken off of both just enough to true them up; then a bush-

ing was made, the inside bored to fit the recessed part of the shaft; this was then perforated with oil holes and split in two halves, the burrs trimmed off and the two pieces put in place, as in Fig. 12. The pulley was slipped on and the thrust collars put on; then the job was complete and ran satisfactorily.

Quite often a bushing such as used in valve rods, etc., will become worn so that it rattles or knocks, yet the bushing is far from being worn out. There are a couple



Worn Shaft
FIG. 10



Turned Recess
FIG. 11

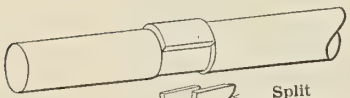


FIG. 12

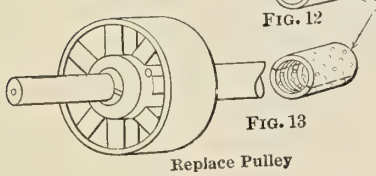


FIG. 13

Replace Pulley

Figs. 10 to 13

of ways to get more service out of such bushings. One is to take the bushing out and give it a heavy coating of solder inside, then ream it to fit the pin. This is called tinning the bushing, and is O. K. where there is a slight clicking or rattle and the pin is true.

The second way to take up wear is shown in Fig. 14. The bushing is taken out and a slot is cut through it with

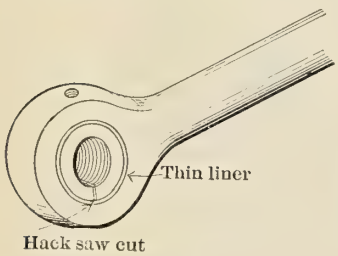
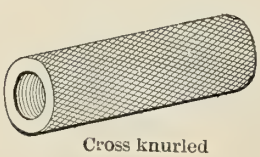


Fig. 14



Cross knurled

Fig. 15

a hack saw; then a thin liner of brass or tin is wrapped around the outside of the bushing and the two are forced back into the rod. This closes the bushing in making the two edges of the slot come flush. The hole is now eccentric and will have to be carefully reamed with a reamer the size of the pin that works in the bushing. Don't forget to drill an oil hole in the liner.

Sometimes a bushing works loose and revolves around in the hole. This allows the oil hole in the bushing to get out of place or blanked off, which will cause rapid wear of the bushing. A cure for loose bushings is to take them out and with a prick punch burr them up all around the outside; then re-drive them. But a better job is to make them larger in diameter by knurling them with a coarse knurl, as shown in Fig. 15. This required putting the bushing on an arbor in the lathe. The writer has cured many troublesome small and large bushings in this way

C. H. WILLEY.

Mercantile Marine Uniforms

For many years the question of a standard and approved uniform for the mercantile marine has exercised the minds of most of its officers. The trouble has been that recognition was denied to rank and competence; and even a master mariner, to say nothing of a chief engineer, had no official right to bear badge or mark of rank. Custom conceded the usage, but there was no right to use, and, although there existed a certain similarity, each company had its own regulations, the badge generally being the house flag of the ship owner.

The practice led to confusion, to the open contempt of commissioned officers of the combatant navy for the officers of the mercantile marine. Indeed, cases of insult and degradation have not been unknown, and the most junior officer of the combatant service considered himself superior and took precedence of the most experienced officer of a large passenger or mail vessel.

The mercantile marine has been the Cinderella sea service, existing by favor, struggling under adversity, of no national importance, and its most capable members enjoyed no recognition, and very few, if any, rights. The war has, however, placed the mercantile marine in the position, if not of combatants, at least in the post of danger, which is also the post of honor. Sacrifices of great magnitude have been met in the spirit of the true tradition of the sea. Without flinching, with contempt for realized danger, and without the protection which armor-plate and big guns afford, the cargo tramp, liner and mail packet have been undeterred. In spite of sinking, mishap and sudden death, there has never yet been any difficulty in finding officers and crew to man the commercial navy.

Recognition has come slowly, but it has come at last. In the same way as the combatant navy, the mercantile marine is to have a standard, universal and acknowledged uniform, with badges of rank and lawful recognition.

A committee with powers of decision representing the Board of Trade, the Admiralty, the Chamber of Shipping of the United Kingdom, the Liverpool Steamship Owners' Association, the Mercantile Marine Service Association, the Imperial Merchant Service Guild and the Marine Engineers' Association, have deliberated ten months on the matter, and a decision has been reached. This matter of a national and authorized uniform has been demanded by the merchant service for years past.

Numerous cases have arisen in which indignity and humiliation have been suffered by merchant service officers, due to their uniforms resembling too closely those of the navy. Now all this is at an end. It has been decided, moreover, that the new uniform may only be worn by certificated officers, and it will differ from the uniforms of the combatant service.

The cap badge will not bear the shipowner's flag; it is considered that the primary function is to distinguish a member of the crew as an officer—not to advertise the company. This proposal met with opposition from many shipowners, but the weight of evidence and the intrinsic importance of the matter carried the day.

The new uniform and the committee's proposals now only await governmental sanction, and absolute details are yet to come. It is, however, certain that the mercantile marine now enter on a new stage of existence, being recognized as a national service, and not merely and simply as an unfortunate necessity.

Recognition involved by certificates of competency and a national and universal uniform, possess disciplinary

powers and give the wearer a real distinction in the scheme of marine matters. It will remove the man involved from the shipowner's sphere of influence and give him a new self-respect founded on valid grounds.

In all respects, the decision is to be applauded, and it is to be hoped that in marking the distinction between the combatant and merchant navies care will be taken that the new official uniform shall at least be reasonable and not conspicuous in a derogatory sense. So far as is known, the cap badge will be a plain anchor surrounded by oak leaves—that is, it will be distinct from the British navy by the omission of the crown.

There is no earthly reason why the proposal should not have been carried into effect decades ago; but now that it has come, a real point of cardinal importance has been gained. The recognition of the engineer is proceeding apace in all quarters, and in common with the navigating officers the engineers of the merchant marine are now to be recognized. A. L. HAAS.

NEW BOOKS

SUBMARINES: A List of References in the New York Public Library. Compiled by Mary Ethel Jameson, Science Division; with a foreword by Simon Lake. Size, 7 by 10 inches. Pages, 97. New York, 1918: New York Public Library.

This list was compiled as an aid to those interested in the history and construction of the submarine boat. It covers published articles on this subject dating back to a period of over two thousand years to the present time, and includes references on submarine signalling.

HIRING THE WORKER. By Roy Willmarth Kelly. Size, 5½ by 8½ inches. Pages, 250; numerous illustrations. New York, 1918: The Engineering Magazine Company. Price, $2.00.

Because of the rapid development and constantly changing ideals of the employment management movement, superintendents, foreman and managers are constantly faced with new problems in securing and keeping employees. This book gives especially pertinent information regarding the vital problem of selection and the gradual education of employees and also regarding the reduction of labor turnover.

RECORD OF AMERICAN AND FOREIGN SHIPPING. Size, 9 by 9¼ inches. Pages, 1,056. New York, 1918: American Bureau of Shipping. Price, $20.00.

AMERICAN BUREAU OF SHIPPING, Great Lakes Department. Size, 12 by 8 inches. New York, 1918: American Bureau of Shipping. Price, $25.00.

The two volumes published by the American Bureau of Shipping contain a complete record of American and foreign vessels in ocean and lake service. Tabulated details of the vessels form the bulk of these annual volumes, but supplementary lists are given in both books of names and addresses of vessel owners, shipbuilders and underwriters. For convenience, lists are also given of vessels with compound names and vessels whose names have been changed.

GENERAL LIST OF MERCHANT SHIPPING (two volumes). Volume I, Steamers and Motor Vessels. Size, 10½ by 11 inches. Pages, 1,300. Volume II, Sailing Vessels. Size, 10½ by 11 inches. Pages, 850. Paris, 1918: Bureau Veritas. Price, complete, £3 10s. Separate volumes, steamers, £2; sailing vessels, £1 15s.

This work, published in two volumes, one for sailing vessels, the other for steamers, has been issued annually since 1870. It contains a complete list of all merchant vessels in the world above 50 tons gross for sailing vessels and above 100 tons gross for steamers. It gives particulars regarding the construction, type, ownership, method of propulsion, port of registry, etc., of each vessel, besides lists of shipowners, shipbuilders and dry docks.

MANUAL FOR THE GUIDANCE OF APPRENTICES ON TRAINING SHIPS. Size, 4¼ by 6 inches. Pages, 215; numerous illustrations. Boston, 1918: Sea Training Bureau, Recruiting Service, United States Shipping Board.

Due to the large number of inexperienced men being taken into the merchant marine service this year to man the emergency fleet, strenuous efforts are being made to train these men in the shortest possible time for the work they are called upon to do. To aid in this work, this Manual has been prepared for the guidance and instruction of apprentices on the training ships of the United States Shipping Board and contains general information regarding deck and engine room service that will be found helpful while the apprentice is in training and later on when he is assigned to vessels of the merchant marine.

ELECTRIC WELDING MANUAL. Size, 5¾ by 9 inches. Pages, 46; numerous illustrations. New York, 1918: Wilson Welder & Metals Company, Inc. Price, $1.00.

Since the wonderful record was made last year in repairing the damaged machinery of German vessels taken over by the United States Government, largely by means of Wilson electric welding equipment, great interest has been aroused in the possibilities of electric welding for all kinds of ship repair and construction work. To further the development of this class of work, this manual has been compiled, giving instruction covering the installation, care, operation and maintenance of the Wilson type of electric welding equipment. Directions are also given to be followed in welding various kinds of metal, specifying the grade of welding wire to be used, the amount of current or heat values to employ, with other useful information for the engineer, foreman or welder. The apparatus and its application are thoroughly illustrated.

SAFEGUARDING THE GATEWAYS OF ALASKA AND HER WATERWAYS. By E. Lester Jones, Superintendent, United States Coast and Geodetic Survey, Department of Commerce. Size, 8 by 10½ inches. Pages, 41. Illustrations, 50. Washington, 1918: Government Printing Office.

Alaska, with its more than 26,000 miles of coast line, cannot be approached without traversing the waters that nearly surround it; the only means to get to the seaport towns and the interior is by ships. For the proper development of Alaska, it is, therefore, imperative that these vast water areas be protected by the most careful survey in locating hidden dangers. The toll in wrecks in Alaskan waters during the past fifty years has been tremendous. To overcome these dangers, the author makes an urgent plea for immediate authorization of new vessels and launches for carrying out a complete survey of Alaskan waters by the Coast and Geodetic Survey.

A NAVAL ENGAGEMENT: A Marine Narrative of Love and War. By Elbridge Gerry Roberts. Size, 5 by 7⅜ inches. Pages, 240. Red Bank, N. J., 1918: Elbridge Gerry Roberts. Price, $1.25.

Just at a time when the patriotism of true Americans is stirred to the utmost by the part our country is playing in the greatest conflict the world has ever known, it is heartening to read from the pen of a new author a vigorous story of heroic deeds and chivalry in Civil War days. Lovers of the sea and adventure will find in Mr. Roberts' narrative a delightful tale of heroism and romance, not all of which, we suspect, is entirely fiction, as the author's father, to whom the book is dedicated, rendered services to his country during the Civil War period for which the country made public acknowledgment and rendered suitable recognition and which might well form the basis of such a story.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Design of Eye Pad and Shackle

Q. (964).—(1) What is the proper safe load, using 12,000 pounds per square inch as the safe fiber stress, on the pad eye (Fig. 1), and how do you determine this safe load? What would be the moment of inertia at "*A-A*" about axes 1-1 and 2-2?

(2) Design a shackle as shown in Fig. 2 capable of handling safely 75 gross tons, using a safe fibre stress, as above.

(3) Have you, or can you refer me to, any book containing data on the rolling of ships in still water other than that contained in such books as White's, Peabody's and Attwood's? Recently it was desired to know what was a safe period of roll for several ships that had been taken over by this Government for which we had no G. M., radius of gyration, or curves of any kind. Was it possible to obtain these data approximately by knowing the length, breadth and depth? Or, if the displacement and other curves had been available, would it have been possible to determine the period of roll that would give a safe G. M.?

A. (964).—1. The axes 1-1 and 2-2 are the same line as shown on the sketch, and the moment of inertia would be

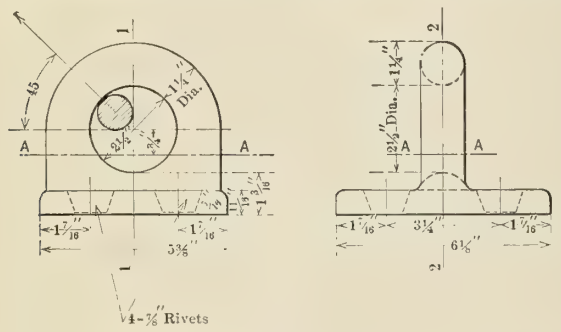


Fig. 1

the polar moment of inertia of the section *A-A*. Probably what is wanted is the moment of inertia about an axis perpendicular to 1-1 and also about one perpendicular to 2-2, which would be the ordinary longitudinal and transverse moments of inertia. These could be obtained with fair approximation as follows: Assume that the section at *A-A* consisted of four semi-circles, each pair separated by a rectangle, so that the total distance across each figure is equal to the distance shown on the sketch. Then for the longitudinal moment of inertia,

I for semi-circle about its $C\,G = 0.00685\,D^4$.

(*A*) $I_{c\,g}$ for most remote semi-circle $= 0.00687 \times \left(\frac{5}{4}\right)^4 = 0.0169$.

(*C*) $I_{c\,g}$ for inner semi-circle $= 0.00687 \times \left(\frac{5}{4}\right)^4 = 0.0169$.

(*B*) $I_{c\,g}$ for rectangle is $\frac{b\,d^3}{12} = \frac{5}{4} \times \left(\frac{1}{4}\right)^3 \times \frac{1}{12} = 0.0016$.

These are all about the centers of gravity of each figure, and must be transferred to the center of gravity of the whole section by the relation $I = I + X^2$ area,

I of A area $= 0.0169 + 0.613 \times \overline{1.36}^2 = 1.150$

I of B area $= 0.0016 + 0.312 \times \left(\frac{7}{4}\right)^2 = 0.966$

I of C area $= 0.0169 + 0.613 \times (2.14)^2 = 2.827$

For one-half section total $= 4.943$

And for total section $I = 9.886$ in.^{4}

The transverse moment of inertia (about axis perpendicular to 2-2) is that of two circles 1¼ inches diameter and 2 rectangles 1¼ inches × ¼ inch.

I of circle about diameter $= 0.049\,D^4 = 0.1198$ in.^{4}

I of rectangle $= \frac{b\,d^3}{12} = \frac{1}{4}\left(\frac{5/4^3}{12}\right) = 0.0407$ in.^{4}

Total $= 0.1198 + 0.0407 = 0.1605$.

and for whole section is

$2 \times 0.1605 = 0.321$ in.^{4}

If the line of action of the force always is in the direction indicated, then the pad eye is improperly designed, as

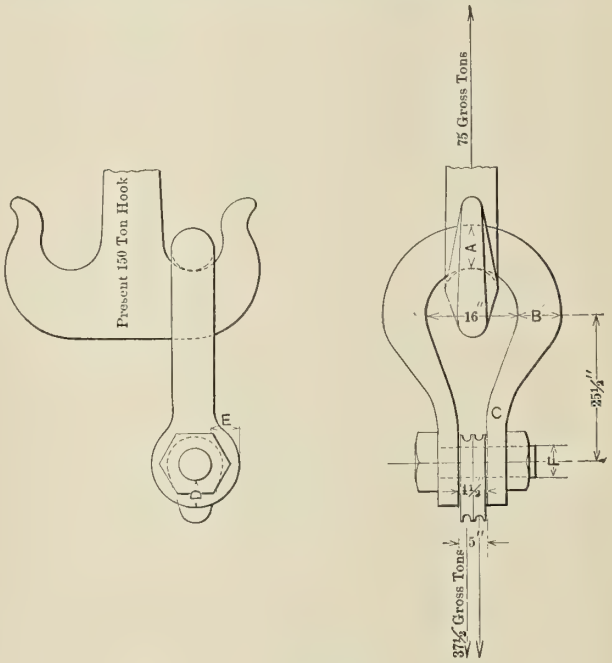


Fig. 2

it should be symmetrical about the line of action of the force. Confining ourselves, however, to this specific problem as given, the weakest section would probably be through the centerline of the eye. If we take a section normal to the force, the stress would be approximately the load divided by the area of the section. If we assume

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fracture is to take place across a horizontal section through the center of the eye, the following computation may be made:

The tension due to the vertical component of the force is

$$\text{Force} \times \text{Sine } 45^\circ = P \times 0.707.$$

This is distributed over an area of 2.45 square inches, so that the direct stress is

$$f_t = \frac{0.707\,P}{2.45} = 0.289\,P.$$

Similarly, the shearing stress is $f_s = 0.289\,P$.

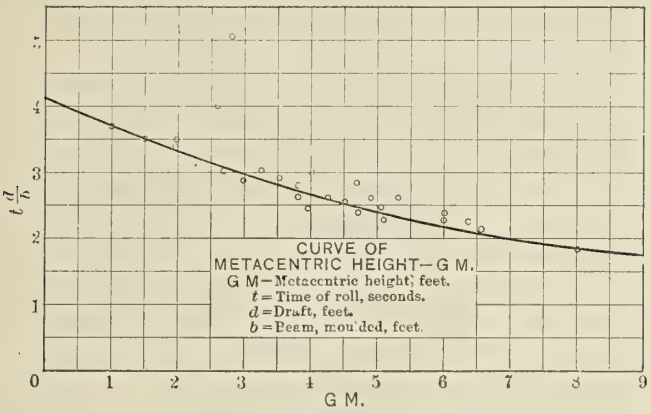


Fig. 3

Combining these by Rankine's expression

$$f = \frac{1}{2} f_s + \tfrac{1}{2} \sqrt{f_s^2 + 4 f_t^2}.$$

$$\text{We get } f = \frac{0.289}{2} P + \tfrac{1}{2} \sqrt{(0.289\,P)^2 + 4\,(0.289\,P)^2}$$

$$= 0.467\,P,$$

and if we limit f to 12,000 pounds

$$P = \frac{12{,}000}{0.467} = 25{,}700 \text{ pounds.}$$

This neglects the link action of the eye, and so probably overestimates the load it would carry, but space here is too limited to take account of that.

2.—Assuming the pin to bear shearing stress only, the diameter F will be determined as follows:

It has to bear a single shear of 37½ tons, or 84,000 pounds. If the allowance fiber stress in tension is 12,000 pounds per square inch, the allowable fiber stress in shear will be about ½, or 6,000 pounds.

The required area will be

$$\frac{84{,}000}{6{,}000} = 14 \text{ square inches.}$$

Diameter = 4¼ inches approximately = F.

For the dimensions E and C there will be four rectangular areas ($E \times C$) to bear 168,000 pounds in direct tension. The area of each will then be

$$\frac{168{,}000}{4 \times 12{,}000} = 3\tfrac{1}{2} \text{ square inches.}$$

E and C dimensions are to be selected to give this area. Make D = to E.

The solution for A and B should properly be by the link theory, and is too involved to be given here. Experiments by Goodenough and Moore (Bulletin No. 18, University of Illinois) give the following for an open link chain, and this might be applied to this case with reasonable accuracy.

$P = 0.4\,d^2\,S$, where
P = safe load on link in pounds,
d = diameter of bar from which chain is made,
S = maximum permissible intensity of stress.

For our case this becomes

$$75 \times 2{,}240 = 0.4\,d^2 \times 12{,}000,$$
$$d^2 = 35,$$
$$d = 6 \text{ inches, approximately.}$$

It is worth noting, however, that 12,000 pounds is rather high for an allowable fiber stress for a unit of this sort, which may be subject to shocks.

3. There is something on metacentric height and rolling in "The Design and Construction of Ships," by J. H. Biles. Some time ago I plotted all the data I could find on time of rolling and metacentric height, and drew the curve in Fig. 3, but have not been able to get much recent data to add to it. I give it for what it may be worth, but do not advise placing much reliance upon it. The "time of roll" is the time the ship takes to roll from extreme starboard position to extreme port (one-half the mathematical time for one vibration).

Tonnage of Vessels

Q. (967).—I would like to have you publish information regarding the different tonnage and weights of vessels to which reference is constantly being made in different newspapers, such as gross tonnage, net tonnage, displacement and deadweight. I would also like to know how the constant is obtained and how applied to find the weight of a ship when docking?

A. (967).—A ton is really a measure of weight, and legally is 2,240 pounds. But in ship work, on account of the varied bulk of the material dealt with and the desire to rate cargoes, etc., on a weight basis when only the volumetric capacity was known, there were evolved various volumetric equivalents, such as 44 cubic feet = 1 ton, for coal; 35 cubic feet = 1 ton, for sea water, etc., and later it was proposed to accept 100 cubic feet as the equivalent of 1 ton of general merchandise. The tonnage given on certificates of registration, legal documents, etc., is generally called registered tonnage, and simply means the cubical contents of the vessel divided by 100, and has no bearing whatsoever upon the *weight of the vessel and cargo,* which is *displacement.* The registered tonnage has three forms: Gross, net and underdeck, all depending upon the spaces included in the measurement.

For example, underdeck tonnage comprises all space below the tonnage deck; gross tonnage is "all spaces below the upper deck, as well as permanently closed in spaces on that deck;" and net tonnage is gross tonnage less certain allowed deductions, supposed not to be available for carrying cargo. These are all simply cubical contents divided by 100, on the basis of 100 cubic feet = 1 ton.

Displacement (sometimes called displacement tonnage) is the actual weight in tons (2,240 pounds) the ship displaces when floating at the draft under consideration. It is a true weight measurement and is divided by figuring the volume of the submerged body of the ship and dividing by 35, on the basis of 35 cubic feet sea water = 1 ton.

Deadweight, or deadweight tonnage, is the carrying capacity of the ship in actual tons of 2,240 pounds, and is the difference in displacement of the ship light, but with stores and fuel, and loaded, but with the same stores and fuel.

As registered tonnage was evolved to obtain a fair estimate for the payment of port charges and taxes, only commercial craft use it. When war vessels use facilities for which they have to pay, their rate is determined usually upon their *displacement,* as they have no registered tonnage, and this has given rise to the use of the word "displacement-tonnage," which is really a misnomer.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

NAVAL BOARD REJECTS BUOYANCY BOX DEVICE

Donnelly System Considered Impracticable for General Use

The board appointed by Secretary Daniels to report on the Donnelly system of buoyancy boxes as installed on the steamship *Lucia* has reported that the *Lucia* installation is not advisable for general adoption under existing conditions by reason of—

(1) The questionable efficacy as a preventive against sinking;

(2) The reduction in cargo-carrying capacity, both deadweight and cubic contents, and

(3) The length of time required for installation.

No Actual Torpedo Test

Although the vessel was not subjected to actual test by the explosion of a torpedo against her side, calculations were made by the board based on results of damage actually received by vessels that had been torpedoed, and it was found that the *Lucia* would, after the explosion, be little better than a water-logged derelict, and, under these conditions, even should she remain afloat, her salvage would prove difficult.

The board points out that while there is no doubt that buoyancy boxes could be installed in sufficient numbers and so located that they would not endanger the stability of a vessel, this can be done only by a loss in actual deadweight capacity of the vessel equal to the weight of the boxes installed, and also a reduction in the cubical capacity of the holds.

Time Requirement Considered

As regards the time required for making an installation of this type on other vessels, the board states that this is a matter of vital importance, as the laying up altogether, or in succession, of a large number of ships for any considerable length of time is not considered permissible in view of the present shipping situation. Mr. Donnelly claims that one week would be sufficient time to install the *Lucia* type of boxes in a vessel. The board gives its opinion that this claim is impossible of accomplishment on account of the large number of boxes involved—12,000 in the case of the *Lucia*—and the wharf and storehouse space that would be required for boxes before they could be installed, which, under existing conditions of congested freight terminals, is impossible to obtain.

Report on Other Methods

In addition to reporting on the installation on the *Lucia*, Secretary Daniels directed the board to investigate and report upon the value and practicability of other means of preserving buoyancy of vessels in war service. In complying with these instructions, the board reported:

(a) That external protection by any means so far suggested is not a practicable solution of the problem of preserving buoyancy, by reason of the reduction in speed and the difficulties in attaching or operating such features.

(b) That attached methods of buoyancy protection by "bulges" and "blisters" are objectionable on account of the reduction in speed and the difficulty in fitting this form of protection.

(c) No form of buoyancy box or any so far suggested material for stuffing affords a practicable solution of the buoyancy problem, on account of the reduction in deadweight and cubic capacity, etc.

(d) A judicious selection of cargo will aid materially in obtaining better buoyancy conditions in the case of damage resulting from flooding of holds.

(e) Internal protection by subdividing bulkheads is the best way to preserve buoyancy of vessels operating in the war zone.

COST PLUS CONTRACTS AT NEWARK SHIPYARD ANNULLED

Price of $960,000 Placed on Vessels Built by Submarine Boat Corporation

Charles M. Schwab, director general of the Emergency Fleet Corporation, has cancelled the cost plus fee contracts of the Submarine Boat Corporation, operating the Newark Government plant, substituting a flat rate whereby the builders will receive $960,000 for each complete 5,000-ton cargo ship.

The original contract with the Submarine Boat Corporation was in all respects similar to cost plus contracts with the other Government yards. The substitution of the new flat rate contract at the Newark Yard is therefore an experiment.

Marine Terminal Projects

The War Department, Washington, D. C., is reported to have decided to spend more than $15,000,000 in establishing a Government shipping station near Baltimore, Md.

The War Department, Washington, D. C., through Major J. L. Lee, Charleston, S. C., will spent $20,000,000 to build piers and warehouses for the quartermaster's department.

The Seaboard Transportation & Shipping Company, Dallas, Tex., is planning to build a wharf.

The Nova Scotia Construction Company, Metropole Building, Halifax, Nova Scotia, has received a contract from the Canadian Department of Marine and Fisheries to build a wharf and pier.

NAVAL APPROPRIATION BILL NOW CALLS FOR $1,610,000,000

Senate Adds $226,000,000 to House Bill

With scarcely any delay, the Naval Appropriation bill passed the Senate without roll call on May 22, carrying $1,610,000,000. The measure, increased by about $226,000,000 over the House authorization, immediately went to conference.

Construction of superdreadnaughts and battle cruisers, provided for in 1916, have been temporarily held up to give way for the building of destroyers. The present bill proposes starting work on each of the more than 150 ships provided for in the three-year programme.

Numerous new projects and extensions at the navy yards and naval stations are provided for in the bill, as well as additional amounts for ordnance and ammunition.

Shipbuilding Contracts

The American International Shipbuilding Corporation, 120 Broadway, New York, Walter Goodenough, general manager, Bellevue-Stratford Hotel, Philadelphia, Pa., which operates the Hog Island shipyard, has received a contract from the United States Shipping Board to build sixty additional steel ships. It is reported that the Hog Island plant now has orders to build 180 ships.

The Redwood City Shipbuilding Company, Redwood City, Cal., has received a contract to build ten concrete ships for the United States Shipping Board.

The yard of the former Samuel L. Moore & Sons Corporation, Elizabethport, N. J., now operated by the Bethlehem Shipbuilding Corporation, is building two 3,500-ton freight ships and a 5,000-ton steel tank steamship.

The Northwest Steel Company, Portland, Ore., J. R. Bowles, president, has received a contract from the United States Shipping Board to build four more 8,800-ton steel steamships.

The American Shipbuilding Company, W. W. Johnston, purchasing agent, Cleveland, Ohio, has received a contract from the United States Shipping Board to build sixty-six ships of Welland Canal size, 261 feet in length. The tonnage of sixty of these will be 4,200 and of the other six, 3,500.

J. F. Duthie & Company, E. C. Gaumnitz, purchasing agent, Seattle, Wash., has received a contract from the United States Shipping Board to build ten 8,800-ton steel ships. The Duthie plant will make improvements and additions at a cost of more than $200,000.

The Liberty Shipbuilding Company, Brunswick, Ga., is reported to have received a contract from the United States Shipping Board to build a large num-

ber of steel steamships. Max Schoolman, Brunswick, is general manager.

The Carolina Shipbuilding Company, which is a subsidiary of the George A. Fuller Company, 175 Fifth avenue, New York, will build a yard at Wilmington, N. C., and is reported to have received a contract from the United States Shipping Board to build eighteen 9,600-ton steel steamships of the Isherwood type.

The Jarrett Shipbuilding Company, Superior, Wis., has an order to build ten 3,500-ton ships for the United States Shipping Board, and two trawlers for the Bay State Fishing Company, Boston, Mass.

Hans Pederson, Seattle, Wash., is the head of the recently incorporated Pederson Shipbuilding Company, which is reported to have received a contract to build eight ships of 3,500 tons capacity for the French government.

The Ambursen Construction Company, 61 Broadway, New York, S. W. Stewart, president, has received a contract from the Bureau of Construction & Repair, Navy Department, Washington, D. C., to build four reinforced concrete fuel oil and coal barges to be used in New York Harbor. These vessels are designed to carry 800 tons of fuel oil and the same tonnage of coal or other cargo. They will be built at the Ambursen Construction Company's yard on the Hackensack River.

The Concrete Shipbuilding Company has opened an office at 260 Stark street, Portland, Me., and plans to build concrete barges and cargo vessels.

F. S. Bowker, Phippsburg, Me., has an order to build a four-masted wooden schooner.

The Taylor Engineering Company, Vancouver, B. C., has received a contract to build a dry dock near Vancouver, to cost $750,000. The plans will be drawn by W. T. Donnelly, 17 Battery Place, New York.

The Fernandina Ship Building & Dry Dock Company, Fernandina, Fla., has received a contract from the United States Shipping Board to build twelve steel sea-going tugs. The contract price is stated to be $3,000,000. This company has a thirty-acre site with 1,200 feet of waterfront, and is planning a complete shipyard to build steel vessels up to 8,000 tons capacity.

Portland Shipbuilding Records

Portland has completed a steel steamship, 8,800 tons deadweight, in 83 working days, establishing a new record. The new vessel was the *Westgrove*, which left the dock of the Columbia River Shipbuilding Corporation at 8:30 o'clock Tuesday morning, April 23, to go to a berth to load a ballast cargo for her trial trip.

The keel of the vessel was started January 15 and the hull launched March 27, and James McKinlay, general manager of the plant, said the time was 83 working days. That lowers the best previous time by 10 days, Skinner & Eddy, of Seattle, having finished a ship of the same size in 93 days.

Then Portland has the record for the fastest wooden ship construction, which was gained by the Grant Smith-Porter Ship Company when the hull of the *Wakan* was floated. An official message to the Washington headquarters of the Emergency Fleet Corporation is that the work was done in 52 working days. The keel was laid February 19.

SHIPBUILDING AND SHIPPING ON THE GREAT LAKES

Lake Yards to Add a Million Tons to the Output Next Year—Lake Production Practically All for Salt Water Service

BY F. H. GRISWOLD

At a conference in Cleveland on May 20 with Charles M. Schwab, director general, and Charles Piez, vice-president, of the Emergency Fleet Corporation, representatives of the Great Lakes shipbuilding companies were assured of contracts totaling about $100,000,000, comprising 130 vessels to cost approximately $800,000 each. The ships will be of 4,200 tons deadweight carrying capacity and of 1,500 horsepower. They will be of full Welland canal size, with a depth of over 28 feet. Deliveries are to be completed by the end of the Lake shipping season in 1919.

The order will be apportioned among the following firms: American Ship Building Company, 60; Great Lakes Engineering Company, Detroit, 24; Manitowoc Shipbuilding Company, Manitowoc, Wis., 12. The rest will be divided among the Toledo Shipbuilding Company, Toledo, the McDougall-Duluth Shipbuilding Company and the Globe Shipbuilding Company, of Duluth.

Extensions of the existing yards, which will be necessary to handle the new programme, will be begun immediately.

3,500-Ton Ships

While in Chicago on May 15, Charles Piez, vice-president of the Emergency Fleet Corporation, stated that 440 wooden ships of 3,500 tons each will be completed in yards on the Atlantic and Pacific coasts, and 125 steel ships of 3,500 tons each will be completed on the Great Lakes by February 1, 1919. The total tonnage of these vessels will be close to 2,000,000. This is exclusive of the larger ships.

Forty wooden ships, declared Mr. Piez, have been launched and will be ready within a month. These are of the Hough type of 3,500 tons each, driven by twin screws. Most of the vessels under construction on the Lakes are of varying types, as the builders are permitted to follow their own methods within certain limits.

Concrete Ships

A considerable number of concrete ships will be built, according to Mr. Piez, including two 3,500-ton steamers and six 7,500-ton tankers. A four-way yard at San Francisco has been authorized for this purpose. The location was chosen largely on account of the climate, so that there will be no interruption in the work of pouring concrete because of frost.

Plan for Building 6,200-Ton Ocean-Going Cargo Vessels on the Great Lakes Feasible, says Hurley

Edward N. Hurley, chairman of the Shipping Board, who was in Chicago recently, confirmed the report that the new plan for building ocean-going cargo vessels of 6,200 tons deadweight carrying capacity on the Great Lakes is being worked out satisfactorily.

According to this plan, both the hull and machinery of the vessels will be fabricated complete on the Great Lakes. The vessel will then proceed through the locks to the St. Lawrence River in abbreviated form. All of the material for completing the vessel will be carried on board to tide water, where 96 feet will be added to the length of the vessel.

Production Division of Emergency Fleet Corporation Establishes Office in Chicago

So many contracts for material and ships' parts have been let in the Chicago district that a Divisional Office of the Production Division of the Emergency Fleet Corporation has been established in Chicago. The office, in charge of E. O. Sessions, is in the Edison Building and occupies half of the ninth floor.

Contracts for materials and parts amounting to many millions of dollars will soon be let in the Chicago district, according to Chairman Hurley. About half of the boilers needed for the new emergency fleet are being built in the Chicago district. One reason why Mr. Hurley is anxious to have more work done in this district is that he has found from experience that he can ship a carload of steel from Gary, Ind., to Seattle in less time than it can be shipped from Pittsburgh to Philadelphia.

Labor Conditions

On account of the stopping of building construction there are many idle workmen in Chicago in the building trades. Union leaders place the number at 20,000 to 50,000. These men belong to twenty-eight trades and include iron workers and carpenters.

Efforts are being made to have these men go into the shipyards, but as they prefer for the most part to remain in Chicago it was hoped that a large amount of concrete construction would be taken up here. It was evident from the interviews given by Mr. Hurley and Mr. Piez to the correspondent of Marine Engineering that this will not be done.

Large Contracts Placed by Hog Island Plant Throughout Middle West

In addition to the purchasing that is handled through the new Divisional Office of the Production Division of the Emergency Fleet Corporation in Chicago, the American International Shipbuilding Corporation is having an enormous amount of work done throughout the Middle West. This corporation, which is operating the Hog Island shipyard, has four shops in Chicago, four in Minneapolis and St. Paul, one in Kansas City, the plant of the Belfontaine Bridge Company, the plant of the Brookville Bridge Company and that of Whitehead & Kales at Detroit. There is also a number of smaller shops that are under the company's control. These shops are all busy on hull fabrication

work and their output is being sent to Hog Island. It is expected that their shipments will soon amount to more than ten carloads a day.

The plants of the Illinois Steel and Inland Steel companies in the Calumet districts south of Chicago are turning out large quantities of steel plates and shapes for yards on the Atlantic coast.

Castings used in the engines come largely from the Middle West, although the 6,000-horsepower turbines to be installed in the larger boats and the 2,500-horsepower turbines to be installed in the smaller boats building at Hog Island are being constructed by the General Electric Company, of Schenectady, N. Y.

Strikers in Chicago Foundries Return to Work

Work in Chicago foundries was tied up recently by a strike of molders and core makers and a stoppage of work in all machine shops using grey iron castings seemed imminent. The men, however, have agreed to return to work and to submit their demands for higher pay to arbitration.

Wooden Yard to Be Converted to Steel Work

The shipyard of Rieboldt & Wolter at Sturgeon Bay, Wis., which has been purchased by the Universal Shipbuilding Company, Inc., capitalized at $1,500,000, will be converted from wood to steel work and will be expanded considerably.

A delegation representing the new company is now in Washington seeking contracts with the Government. Upon the return of this delegation definite plans for the future of the yard will be decided upon. Mr. Wolter will remain with the firm during the coming year at least.

The last act of the old firm, which had been in existence twenty-five years, was to launch the steamer *Sturgeon Bay*, which is one of the fleet which recently started for salt water.

Illinois Manufacturers Seek Government Contracts

The Illinois Manufacturers' War Industries Bureau has been formed in Chicago under the auspices of the Illinois State Council of Defense for the purpose of aiding owners of plants to obtain Government contracts. The Chicago Association of Commerce, the Illinois Manufacturers' Association and numerous other commercial organizations throughout the State are back of the move. Headquarters are at 72 Monroe street, in the office of the Illinois Manufacturers' Association.

The Bureau is making a survey of industrial plants, and so far 700 have reported that they have no war work and would like to get contracts. While other parts of the country report that workmen and houses are scarce, there are thousands of idle workers in Chicago, and real estate men claim there are 20,000 vacant flats and houses. It seems certain that there are many plants that can handle far more work than they now have. Both Mr. Hurley and Mr. Piez visited the office of the Bureau while in Chicago.

Construction of Canal Boats Begun

The Chicago Shipbuilding Company is at work on "canalers" that are 261 feet long, 43 feet 6 inches beam, and from 20 to 25 feet depth. They are equipped with triple-expansion reciprocating engines.

Lake Production for Ocean Service

It is said that of all the ships being built on the Great Lakes only one is to remain in Lake service. The thirty-four ships built during the fall and winter are all, it is believed, in salt water by this time. According to official announcement, it was planned to have them out of the Lakes by May 10, but no information has been given out regarding their movements. They total about 100,000 tons. Four of the ships sailed as soon as the Lakes and the St. Lawrence River were open to navigation. The remainder took on cargoes at Chicago, Duluth and other points.

These vessels are going immediately into transatlantic service. The official programme calls for the completion of twenty-three ships in shipyards on the Lakes during May. Of these, sixteen or more are so far advanced that they have begun to take on crews and cargoes. They total 53,000 tons and have been ordered into the New England coal-carrying trade by the Bureau of Operations of the Shipping Board.

Experimenting with Concrete Boiler

The Union Iron Works, San Francisco, Cal., is experimenting with the construction of a Scotch boiler in which the shell will be made of concrete held between thin steel plates.

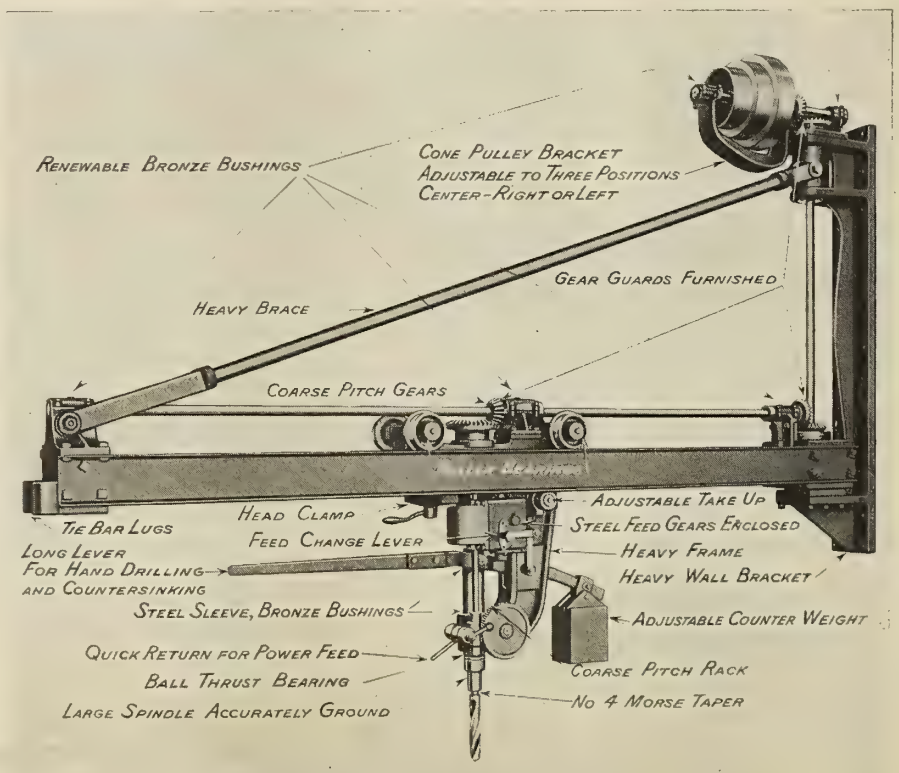
New Wall Radial Drilling Machine

The Lynd-Farquhar Company, Boston, Mass., has placed on the market a new wall radial drilling machine in which particular attention has been given to locating the entire control of the drill within easy reach of the operator. The arm on which the drill is mounted is constructed of extra heavy channels, planed on the top and bottom, with suitable supports at each end. The outer end is supported from the top of the wall bracket by heavy steel braces. The wall bracket is heavily ribbed, and where bolted to the wall is 10 inches wide and 8 feet 10½ inches high. At the top of the bracket a bevel gear housing can be located at any one of three positions for convenience in connecting the belt drive from a countershaft. In place of the bracket that carries the bevel gear housings, a 5 to 7½ horsepower variable speed motor can be mounted on suitable brackets.

The drill head is mounted on four flanged wheels fitted with roller bearings. All gears are accurately cut from the solid, the feed gears being of steel. The bearings are bronze bushed and renewable.

There is a hand lever feed nicely counterbalanced by an adjustable weight for light drilling and countersinking. The gear power feed has two changes, .015 to .025 per revolution of the spindle. The feed can be changed while the drill is in operation and provides a good range of feed for drills up to 2½ inches diameter. Automatic release of power feed is provided at the extreme traverse of the spindle to prevent damage to the feed gears.

The spindle is of high carbon steel 2½ inches diameter in the bearings and runs in long bronze bushings within a steel sleeve. The spindle has a 7-inch



Wall Radial Drill Manufactured by Lynd-Farquhar Company of Boston

Fig. 1.—General View of New South Philadelphia Works of the Westinghouse Company

traverse, a No. 4 Morse taper hole and is fitted with high-grade, heavy duty thrust bearing. The upper end of the spindle is 2⅜ inches diameter and slides through a heavy steel driving sleeve to which is keyed the main driving gear. An eccentric wheel on the underside of the arm keeps the carriage in proper adjustment along the channels.

The South Philadelphia Works of the Westinghouse Electric & Manufacturing Company

The greatly increased demand for electrical apparatus has led naturally to an increased output of steam turbine generator units and their accessories. In order to facilitate the manufacture of this line of apparatus, the Westinghouse Machine Company was a short time ago consolidated with the Westinghouse Electric & Manufacturing Company, and is now known as The Machine Works of the Electric Company.

Manufacturing facilities at East Pittsburgh, the location of both plants, have about reached their limit and further increases there were deemed inadvisable, on account of the lack of available land and the fact that there are already over 25,000 people employed in these works. It therefore became necessary to select a new site which would be capable of expansion to a size comparable with East Pittsburgh.

The site selected is at Essington, or South Philadelphia. This property, which embraces 500 acres, with a frontage of 4,500 feet along the Delaware River, lies nine miles south of Philadelphia, and can be reached by the Pennsylvania, the Philadelphia & Reading Railroads, or the Philadelphia Rapid Transit Company. The Delaware River affords a means of transportation, but as yet no docks have been built. The plant, a considerable portion of which is now in operation, is devoted entirely to the production of ship propulsion machinery for the Submarine Boat Corporation and the Merchant Ship Building Corporation, as agents for the Emergency Fleet Corporation, and also for the United States Navy.

There have been erected so far seven buildings, including the pattern storage shop, foundry, forge shop, power house, two machine shops and an erecting shop. The power and lighting systems possess a number of features of unusual interest. Desiring to make use of central station power, and at the same time secure steam for heating the buildings economically, the management has effected an arrangement with the Philadelphia Electric Company, which distributes current in this territory, that promises to work out unusually well for both companies.

Steam heat is required in the winter months, but this demand falls off, naturally, in the summer months, when no steam is required except for testing purposes. On the other hand, during the winter months, the Philadelphia Electric Company has a very heavy load, which is materially lessened during the summer months. An agreement was effected whereby the Westinghouse Company operates its own plant, non-condensing, during the winter and utilizes the exhaust steam, and when there is no need for heat, current for the operation of the works is secured from the Philadelphia Electric Company.

All of the buildings, with the exception of the pattern storage shop, are of heavy steel construction, the walls are of tile, the sash of steel, the roofs of saw-tooth type, consisting of concrete slabs covered with asphalt asbestos waterproofing material. The pattern storage shop, which at the present time houses the offices, is of reinforced concrete, of a construction known as flat slab mushroom type; the intermediate panels between the concrete posts are of tile.

The buildings are all well lighted and equipped with the most modern tools and facilities for the comfort and convenience of the workmen. Transportation between the buildings and the yards is effected by storage batery trucks, some of which are equipped with Edison batteries and some with lead batteries. Every machine in the shops is electric motor driven, and all are equipped with the latest and most approved safety devices.

Mr. H. T. Herr, vice-president, was entrusted with the seclection of the site and general direction of the construction and operation of the plant. Mr. R. B. Mildon, assistant to the vice-president, has been in direct charge of the construction work.

All business relations with Westinghouse, Church, Kerr & Company, the builders, have been handled by Calvert Townley, assistant to President E. M. Herr, who has had final approval of all arrangements.

Copy of February, 1917, Issue of Marine Engineering Wanted

A. L. Haas, a frequent contributor to Marine Engineering, will be specially grateful to any reader of this magazine who can spare a copy of the February,

Fig. 2.—Interior of Machine Shop at New Westinghouse Plant

1917, issue. This may be sent to the Editor for forwarding or sent direct to 146 Crowborough Road, Tooting, London, S. W., England.

The Tower Whirler—A New Development for Speeding Up Shipbuilding

One of the most necessary appliances about the shipbuilding plant is apparatus which will raise, move and place materials. The ideal machine of this kind is one that will lift any load within its rated capacity from any point within the reach of its boom and deposit it safely and expeditiously at any other desired point; one that will move quickly from end to end of the ways with its load or rotate quickly from material yard to shipways. It must be placed close alongside the ship being built, yet must not interfere with the operation of freight cars.

Such a machine, called a "tower whirler," is supplied by the Dravo-Doyle Company, Pittsburg, Pa. It consists of a whirler mounted on a tower from 30 to 55 feet high, running on a track having a gage of 16 to 20 feet. The whirler has a boom 75 feet, or longer, and can easily lift a 10-ton load from any point within ten feet of its center pin. It can carry the load quickly to any point along the length of its trackage, and thus, on account of the great capacity and long reach, can serve a large territory.

Several advantages are gained by mounting the whirler on a high movable tower, it is claimed. In the first place the machine is carried above any material or supplies piled on the ground, so that the long boom is permitted free use at extreme range in any part of the yard. The operator is enabled to watch his load closely every moment without the need of relying on a signalman. This often saves the cost of employing an additional man. The clearance under the tower is high enough so that an ordinary box car can pass under. Thus the whirler can unload directly from the cars and place the material either in the storage yard or in position on the ways.

In nearly all cases timber is used for the construction of the tower. Timber has several advantages not possessed by steel for this purpose. It is easy to assemble, low in first cost, easy for the ordinary workman to repair, it has great flexibility, is easy to ship, and, most important, *can be obtained*. Whirlers are operated either by steam or electricity. The ideal motive power is, of course, electricity.

Tower Whirler in Operation at Shipway

Having a track of 16- to 20-foot gage makes a very large, firm wheelbase and enables the full load to be lifted at the end of the long boom without the necessity of large counterweights. The wide gage allows for the placing of an ordinary gage track between the rails and the running of locomotives and cars under the tower. Rotation of the whirler is accomplished by means of a vertical shaft driven by a motor or an engine and bevel gears. The vertical shaft has a pinion meshing with a large gear on the truck.

Whirlers can be obtained from stock, or in sixty days at the latest. The average cost of a whirler varies from $15,000 to $25,000, and one can be shipped, complete, in an ordinary flat car. On an order of six whirlers, one could be shipped every ten days to complete the order in sixty days. For a shipyard of three ways, four whirlers would serve every lifting and placing purpose.

The whirlers at the extreme ends of the yard cover a space of 73 feet from the centerline of the whirler track, while those between the ways allow operation on either of two hulls or two whirlers on one hull.

As the great requirement now is for speed, it is pleasing to note that whirlers can operate very quickly. In the case of a 10-ton whirler, the full load can be lifted at 73 feet from the centerline on a two-part line at the rate of 75 feet per minute (or five tons on a one-part line at 150 feet per minute). The boom can be raised through an angle of 57 degrees in 25 seconds, and the whirler will make a complete 360 degrees in 30 seconds. The entire tower will move along the track with full load at the rate of 250 to 300 feet per minute.

New York State Barge Canal Opened for Navigation

The New York State Barge Canal, completed at a cost of $150,000,000, was opened to through traffic between the Hudson River and the Great Lakes on May 15. Formal observance of the opening will be held at a later date.

The main line of the Barge Canal is 352 miles long and the total length of the New York system of navigable inland waterways 532 miles.

Wainwright Turbine Bearing Oil Coolers

The use of steam turbines for ship propulsion has increased greatly the use of turbine bearing oil coolers as an auxiliary apparatus in marine work. In such installations requiring forced feed lubrication of bearings, better results are obtained at high oil velocities, as it is of advantage to circulate a large quantity of oil through a small range of temperature, thereby keeping the oil moderately near the bearing temperature, for the reason that warm oil absorbs heat more readily than cold oil.

With the exception of the tubes, Wainwright oil coolers are made of cast iron throughout, thereby eliminating the possibility of corrosion from sea water in marine work and assuring durability and long service. By the use of the Wainwright corrugated copper tube, a considerably higher rate of heat transmission is obtained in the cooler, as the tube corrugations cause a turbulent action and force all particles of the oil against the wall of the tube.

Wainwright Oil Cooler

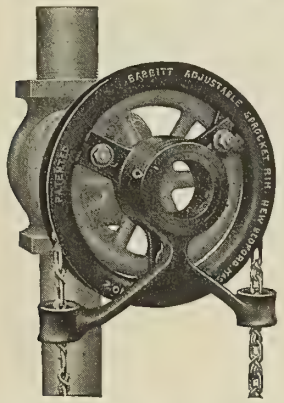
Wainwright coolers are designed on the counter-current principle with horizontal baffles cast into the shell, the warm oil entering the cooler near the point of discharge of the warm water and the cool oil being delivered from the cooler at a point where the coldest water enters. This assures a uniform rate of heat transmission through all parts of the cooling surface. The tubes are expanded rigidly into both tube sheets, the small amount of expansion being taken up by the corrugations themselves. All flanges are fitted with special oil-proof gaskets. The tubes used are straight, easily cleaned or replaced, and oil connections are located in separate channels with covers on the ends, making it possible to open the entire outfit for inspection or repair without breaking any pipe connections. The tube heads are cast separately and bolted to the shell, eliminating any chance of breakage due to shrinkage strains of the castings.

The manufacturer of the Wainwright oil coolers, the Alberger Pump & Condenser Company, 140 Cedar street, New York City, states that the construction offers compactness and maximum heat transmission with minimum requirements of cooling water and friction losses.

Chain-Operated Wheel for Valves

Up to the present time sprocket rims for the operation of inaccessible valves have been limited almost entirely to land installations, but the recent invention of a marine rim by the Babbitt Steam Specialty Company, of New Bedford, Mass., has made it possible to use such a device on board ship.

This device, called the Babbitt adjustable sprocket rim, can be attached to any valve in a few minutes by means of hook bolts. The special chain guard prevents the chain from jumping off the



Valve Wheel Fitted with Marine Rim

wheel, and also makes it possible to use the device where the valve stem is not horizontal.

As opposed to other devices usually used on board ship, the Babbitt rim is very much cheaper, much more quickly installed and takes less room. There are no handles or rods occupying valuable space. When not in use the chain is hung on a special hook or is tied around a pipe. This keeps it out of the way and prevents it from rattling.

165-Foot Fir Spar Hauled from Coast to Coast

To ship a 165-foot spar weighing 12 tons from the Pacific to the Atlantic coast, four flat cars, each 45 feet long, were required, and special underpinning and swiveling arrangements were made necessary in order to allow the great spar to take the curves.

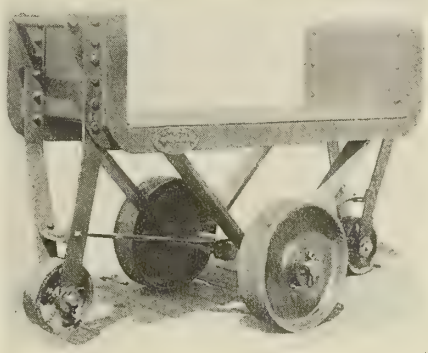
This huge spar was ordered from the Pacific Mutual Timber Company, of Tacoma, Wash., and was shipped from Onalaska, Wash., to Paul A. Lagno, a spar maker of Brooklyn, N. Y. In addition to the big stick, the shipment also contained forty-one other spars, ranging from 70 feet to 90 feet in length and from 14 inches to 22 inches in diameter at the butt.

A Modified Welding Process for Repairing or Joining Broken Aluminum Parts

The Alumunite Manufacturing Company, Inc., Corona, N. Y., has placed on the market a new alloy under the name of "alumunite," which is said to possess unusual qualities in the repairing of aluminum. This alloy has been perfected as the result of years of patient, scientific investigation and experiment. By its use it is claimed that aluminum parts can be repaired at a low cost and with none of the dangers due to high temperature welding. Alumunite flows rapidly at a temperature of 350 degrees F. as against 900 to 1,200 degrees F. required by other welding processes. Alumunite shows a tensile strength on lap and butt joints of 8,500 to 12,000 pounds per square inch.

"High Level" Truck Increases Machine Operators' Efficiency

Much time is lost and the efficiency of the machine operator is considerably reduced when he finds it necessary to stoop or bend in transferring the material from truck to machine and vice versa.



"High Level" Truck

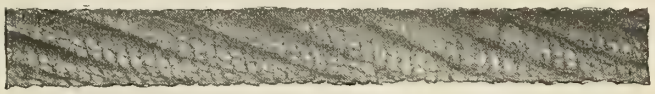
It was to eliminate this source of loss that the new "High Level" truck shown in the accompanying illustration was designed.

It is so constructed that the whole load is balanced on the center axle, which is provided with large diameter, wide tire roller bearing wheels, and, although of very heavy design, the rated capacity being two-third ton, it can be moved about fully loaded with the greatest ease.

The truck was designed and built by the Orenstein-Arthur Koppel Company, of Koppel, Pa., and is now in use in many of the large manufacturing plants throughout the country.

New Type of Wire Rope

A type of wire rope in which the steel wire strands have been specially covered with tarred hemp marline is now being marketed by the Geo. C. Moon Company, of Garwood, N. J.



Steel Wire Rope with Covered Strands

The marline covering prevents friction between the strands when the rope is in use, affords protection against moisture, keeps abrasive dust away from the wire and affords protection to the workmen's hands.

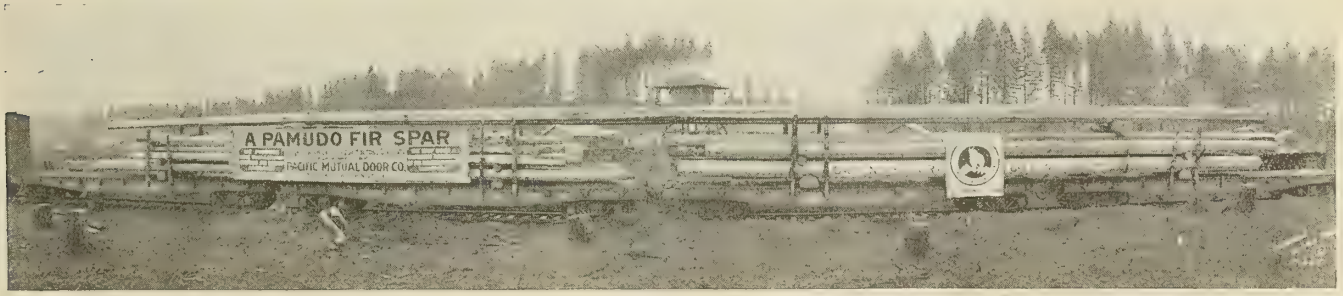
This "Crescent Hemp-Clad" wire rope, as it is called, has excellent advantages in marine service. It is flexible and can be coiled and handled as easily as manila rope, it is claimed; has from three to five times the strength for equal size, depending upon the grade of wire used, will not rust, does not swell when wet, is not affected by ice in winter and can be fastened around cleats or bits with the ease of manila rope.

For equal strength, Crescent Hemp-Clad weighs only half as much as manila rope, and, as it is only one-third of the diameter, it may be used on smaller blocks.

Record Set in Wooden Ship Launching

Portland smashed another world's record when the Grant Smith-Porter Shipbuilding Company launched the new Government steamer *Caponka* in 50 working days from the date of laying her keel. The best previous record also is held by the same company through its construction of the hull of the steamer *Wakan* in 52 working days. She was launched April 20. No other company in the United States building wooden vessels has managed so far to approach a duplication of either of these performances. Had certain material been available, the *Caponka* would have been launched in 48 days from the time the laying of her keel started. Delay was experienced in waiting for a shaft.

Helen Scott Cantine, 14-year-old daughter of E. L. Cantine, inspector at



How a Spar 165 Feet Long, 28 Inches Diameter at the Butt, Weighing 12 Tons, Was Shipped Across the Continent on Four Flat Cars

the plant for the Emergency Fleet Corporation, had the honor of christening the *Caponka*.

The eight ways of the yard are divided into two sections, one being designated as the south ways and the other as the north ways. The south ways, on which the *Caponka* was built, are in charge of C. W. Goodman, general foreman, and Ben Cassady, general fastener foreman, while the north ways are looked after by Bert Pettitt and Allan Yonker in the respective positions.

Lloyd J. Wentworth, district officer of wooden ship construction in the Portland and Columbia river district, forwarded a message of the record launching to Washington, D. C., immediately following the event.

Perhaps You Can Render Valuable Service to Your Country

Important chemical and other technical engineering work necessary for the prosecution of this war is being carried on by the Bureau of Mines Experiment Station at Washington, D. C. The services of trained men of the following classifications are urgently needed:

Bacteriologists, biologists; chemists, inorganic; chemists, organic; chemists, physical; chemists, electro-, chemical engineers, draftsmen, electrical engineers, instrument makers, laboratory assistants, laborers, machinists, physiologists, plumbers, steamfitters, stenographers, skilled labor of various kinds.

If your training fits you for any of these occupations, send to the

BUREAU OF MINES,
American University Experiment Station, Washington, D. C.,

for blank forms. When properly executed and returned by you, these forms will be placed on file, and when a vacancy occurs you will be considered for it and will be notified if your services are desired.

If you are a registrant in the draft and have not yet been ordered to camp, it may be possible to have you immediately inducted into the service for work here.

If you are *not* in the draft, but feel that you wish to serve your country in the present crisis, you can enlist or serve as a civilian.

Serve your country where you can serve it best.

Navy Steam Engineering School

The United States Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this training known as the United States Navy Steam Engineering School has been established at the Stevens Institute of Technology, Hoboken, N. J., under the guidance of Dean F. L. Pryor as Civilian Director.

The course consists of five-months' training, divided as follows: One month of military training at the Naval Training Camp, Pelham Bay Park, New York; one month at the United States Navy Steam Engineering School; two months' practical training on board ships and in repair shops in the vicinity of New York; one month finishing course at the United States Navy Steam Engineering School.

The school is open to men between 21 and 30 who are physically qualified, of thorough ability and officer-like character, and who have completed the engineering course at any recognized technical school.

This school presents particularly desirable opportunities to the young technical man, both in affording him a proper outlet for his trained facilities during the war and in rounding out his college work with a practical course and school experience which will be of value to any engineer.

The service that a graduate from the school will perform will be that of an engineer-officer in the auxiliary service of the navy. A graduate of the school will be commissioned an ensign in the Naval Reserve Force.

Information has been sent to all registered technical schools and should be on file at the President's office. For any additional details application can be made to the Civilian Director, United States Engineering School, Stevens Institute, Hoboken, N. J.

Free School of Marine Engineering

Exceptional opportunities for those desiring to qualify as engineers in the new merchant marine of the United States are offered by the Seamen's Church Institute, of 25 South street, New York City. In connection with the reorganization of the instruction in its School of Navigation and Marine Engineering, the Institute, by arrangement with the United States Shipping Board, will give free tuition to men of the requisite experience who wish to fit themselves to obtain licenses as engineers in the great transport fleet which is to convey men and munitions across the seas.

DAY AND NIGHT CLASSES

Day and night classes are provided, so that pupils may be able to support themselves during their preparation. All applicants must be native or naturalized Americans more than nineteen years of age. Those eligible for the service must be able to meet the following requirements:

Two years' experience as marine oiler or water tender; or graduate from the engineering class of a nautical schoolship; or graduate in mechanical engineering from a school of technology; or a stationary engineer for one year; or a locomotive engineer's license for one year; or a journeyman machinist on marine, locomotive or stationary engines for one year; or an apprentice machinist of six months' experience on marine engines; or an engineer of lake, bay, sound or river steamers; or have had three years' experience as fireman on an ocean-going vessel.

TUITION COURSES

In addition to the free courses provided in co-operation with the Shipping Board, the School offers courses at nominal rates for all who desire to qualify themselves for masters or mates and for all phases of sea duty. The course in marine engineering is constantly supplemented by practical work on board a modern steamship in New York Harbor.

NEW SHIPYARDS AND EXTENSIONS

Additions and Improvements

The Standard Shipbuilding Corporation, 44 Whitehall street, New York, J. Messel, purchasing agent, has leased the shipbuilding works of the Birch Point shipyard, Wiscasset, Me., and will build six vessels there.

The Pacific Construction Company, Coquitlam, B. C., is planning to build four additional ways. The company is reported to have received an order to build fifteen ships.

The Bangor-Brewer Shipbuilding Company has been organized in Bangor, Me. Charles D. Stanford is president and George H. Hamlin, treasurer.

The Svendsen Shipbuilding Company has been organized by A. A. Roman and P. Svendsen, 351 Sixty-fourth street, Brooklyn, N. Y.

The Coastwise Ship Engineering Corporation has been organized in Boston. James L. MacEachern is president and William W. Rich, 85 Devonshire street, treasurer.

It is reported that the Virginia Shipbuilding Corporation, Alexandria, Va., has awarded contracts to the Raymond Concrete Pile Company, 90 West street, New York, and to Frederick T. Ley Company, 19 West Forty-fourth street, New York, for the construction of a shipbuilding plant on the Potomac River, to cost about $5,000,000.

Cristoffer Hannevig, 139 Broadway, New York, the head of Hannevig & Company, of Norway, has acquired a tract of land in New Jersey, where, according to report, there is to be built one of the largest shipyards in the world, to construct vessels for Norwegian owners.

The Todd Shipyards Corporation, 15 Whitehall street, New York, has given a contract to B. S. Cronin & Company, 573 Clinton street, Brooklyn, for a $100,000 addition to its shipyard.

The Wilmington Wood Ship Construction Company has been organized at Wilmington, N. C., to succeed Cushman & McKown, builders of wooden vessels.

The Adamant Brick Company, Pinellas Park, Fla., is planning to build several concrete ships.

The Athens Shipbuilding Corporation has been organized by H. R. Avery, Athens, N. Y., and E. S. Anthony, Coxsackie, N. Y.

The Federal Shipbuilding Company, 71 Broadway, New York, has bought twenty-one acres of land on the west bank of the Hackensack River, where it is proposed to build an enlargement to its plant.

The Strachan Shipbuilding Company, of Brunswick, Ga., according to report, is planning to build a steel shipyard on a site to be decided later.

The Ferguson Steel & Iron Company, Buffalo, N. Y., has begun work on a shipyard on the Buffalo River. Captain James E. Ferguson is president. The yard will build vessels for the United States Navy, but later on it is planned to equip it for building all types of steel vessels.

It is reported that the Foundation Company, 233 Broadway, New York, purchasing agent E. E. Jenkins, will build a $1,250,000 plant at New Orleans,

where steel ships of a new unsinkable type will be built.

The Norway Pacific Dry Dock & Construction Company, Everett, Wash., is planning to build a shipyard.

The Fairhaven Shipbuilding Company has been organized at Fairhaven, Mass. C. G. Whiton, New Bedford, is president.

It is reported that the Gildersleeve Ship Construction Company, purchasing agent Alfred Gildersleeve, Gildersleeve, Conn., is about to erect a shipyard at Portland, Conn., where the company will build ten 114-foot lighters.

The Narranganset Shipbuilding Company has been organized at Fall River, Mass. Herder C. Wood, Fall River, is president, and Albert B. Murdough, Watertown, Mass., is treasurer.

The Foundation Company, 233 Broadway, New York, Franklin Remington, president, has formed several subsidiary companies. One has been formed for the purpose of taking over the shipbuilding plant of the Reid Wrecking Company, Port Huron, Mich. Another has taken over the Carpenter-Watkins Company, Savannah, Ga., where it will build two hundred 110-foot wooden barges for the United States Shipping Board.

The Foundation Company has also made an offer to take over the M. A. Sweeney Shipyard & Foundry Company, the Howard Shipyard & Dry Dock Company, and the B. S. Barmore Shipyard, Jeffersonville, Ind., where it plans to establish a plant for manufacturing ship parts, river boats, barges, etc.

It is reported that a new corporation will establish a shipyard at Milwaukee, Wis., for the construction of both steel and reinforced concrete ships. The corporation is being organized by members of the Society of Iron & Steel Fabricators and the Concrete Builders' Association of Milwaukee.

The Marine Department of the Houston Bank & Trust Company, Houston, Tex., is building concrete ships. E. V. Heidenrich, of the Heidenrich Engineering Company, Kansas City, Mo., is consulting engineer.

The Cleveland Builders Supply Company, Cleveland, Ohio, will build a plant for the construction of concrete ships of Welland Canal size.

The Dauntless Shipbuilding Company, Essex, Conn., S. S. Bowles, general manager, is planning improvements to cost about $100,000.

The Bangor Shipbuilding Corporation has been organized in Bangor, Me., to build wooden schooners. Chas. Murray is president, and Roscoe H. Wing, general manager.

Capt. O. A. Gilbert, of the Boston Ship Transport Company, Boston, Mass., has purchased the Story & Wardwells shipyard, East Boston.

The Johnston Shipbuilding, Repair & Dry Dock Company has been organized in Brooklyn, N. Y., by G. Johnston.

The Norfolk Concrete Boat Company, McKevitt Building, Norfolk, Va., is planning a shipyard for the construction of concrete-steel vessels. Fred B. Doty is president.

Philip Morrison, of the Seaborn Shipbuilding Company, Tacoma, Wash., according to report, will erect a ship equipment plant.

The Concrete Shipbuilding Company, Savannah, Ga., has been organized by Ivar Widing, Savannah, and others.

PERSONAL

Howard Coonley, president of the Walworth Manufacturing Company, of Boston, has been appointed vice-president of the Emergency Fleet Corporation in charge of the legal, financial, auditing, contract, statistical and executive and administrative divisions.

J. L. Ackerson, naval constructor, U. S. N., has been appointed assistant to the Director-General of the Emergency Fleet Corporation. He was formerly assistant to Vice-President Piez.

William G. Coxe, formerly president of the Harlan & Hollingsworth Corporation, Wilmington, Del., has been appointed Director of Ship Construction in the private yards along the Delaware River for the Emergency Fleet Corporation.

H. C. Sadler, professor of naval architecture and marine engineering of the University of Michigan, Ann Arbor, Mich., has been appointed assistant manager of steel ship construction of the Emergency Fleet Corporation.

A. Merritt Taylor, former Director of Transit of Philadelphia, has been appointed director of the new division of passenger transportation and housing of the Emergency Fleet Corporation.

J. Willison Smith, vice-president of the Land Title & Trust Company, Philadelphia, has been appointed assistant director of housing for the Emergency Fleet Corporation.

Frederick D. Herbert, New York manager of the Terry Steam Turbine Company, has been elected president and general manager of the Kearfott Engineering Company, Inc., New York. For a number of years Mr. Herbert was editor of Marine Engineering, and for the last ten years has had charge of the New York offices of the Terry Steam Turbine Company, Hartford, Conn. Mr. Herbert will continue to handle the marine account of the Terry Steam Turbine Company, with offices at 95 Liberty street.

H. E. Squire, assistant engineer California State Board of Harbor Commissioners, has been called to Washington to assist R. J. Wig, of the United States Shipping Board, who is giving special attention to the concrete division.

William Newman, naval architect, has resigned as works manager of the Polsen Iron Works & Steel Shipbuilding Company, Toronto, Ontario, Canada.

J. J. Eason has been appointed works manager with the United States & Cuban Allied Works Engineering Corporation, operating the Havana Iron Works and the Havana Dry Dock Company in Cuba. His address is Havana Iron Works, Cuba No. 51, Havana, Cuba.

E. E. Maher has been appointed by the Terry Steam Turbine Company, Hartford, Conn., as manager for the Chicago district, with offices at 1328-29 McCormick Building, 322 South Michigan avenue. John T. Stout has been appointed manager of the New York office of the Terry Steam Turbine Company.

D. C. Newman Collins, architect and engineer, announces change of address to 14 John street, New York City.

George Q. Palmer has been elected chairman of the Board of Directors of the Alberger Pump & Condenser Company, New York. The other officers are William S. Doran, president; William R. Wilson, vice-president; Richard C. Williams, secretary, and Frederick A. Brockmeier, treasurer.

V. F. Signorelli, formerly secretary and assistant treasurer of the Southwark Foundry & Machine Company, Philadelphia, Pa., is now office manager and auditor of the Foundation Company-Carpenter-Watkins, Inc., Brunswick, Ga.

C. L. Bergendahl is planning to erect a steel shipyard at Wilmington, N. C.

The Jacksonville Ship Outfitting Yard of the California Brick Company will establish a plant at Jacksonville, Fla., for the mechanical equipment of ships. It is stated that the company has already received a contract to complete more than twenty wooden hulls for the United States Shipping Board. The president is W. S. Dickie, Kansas City, Mo.; vice-president, R. C. Penfield, Chicago, Ill.; general manager, John C. Temple, Jacksonville.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., will enlarge its plant.

Ira S. Bushey & Son, 764 Court street, Brooklyn, N. Y., have acquired a frontage of 500 feet on the Gowanus Canal as a site for a new plant.

The Galveston Dry Dock & Construction Company, Galveston, Tex., has awarded a contract to the Missouri Valley Bridge & Iron Company, Leavenworth, Kan., to construct its 10,000-ton floating dry dock on Pelican Island; the estimated cost is $850,000. The plans and specifications are by William T. Donnelly, 17 Battery Place, New York.

The Newport Shipbuilding Corporation, Los Angeles, Cal., has just been incorporated for the purpose of building steel-concrete vessels. Lloyd R. Coffman, W. R. Jamison and others of Los Angeles are the incorporators.

The Cast Steel Ship Company has been incorporated by J. H. Mottola, H. H. Hoffnagle and L. F. Sniffin, 49 Wall street, New York.

The International Sales Corporation, Munsey Building, Washington, D. C., is an organization seeking to personally represent in that city the larger industrial concerns who have or may have business with the numerous Government boards. It is manufacturing, under contract with the Shipping Board, several iron products and is prepared to take over the entire outfitting of wooden ships.

OBITUARY

Frederick Remsen Hutton, honorary secretary of the United Engineering Society and for twenty-five years secretary of the American Society of Mechanical Engineers, died on May 14 in New York, aged 65. From 1877 to 1907 Professor Hutton held the chair of mechanical engineering at Columbia and for six years was Dean of the Faculty of Applied Science.

Edward C. Meier, president of the Heine Safety Boiler Company, Phoenixville, Pa., died suddenly in Philadelphia on May 7 while attending a meeting of the District Production Division of the Emergency Fleet Corporation. Mr. Meier was 48 years old and was the son of the late Col. E. D. Meier, founder of the Heine Safety Boiler Company and former president of the American Society of Mechanical Engineers.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

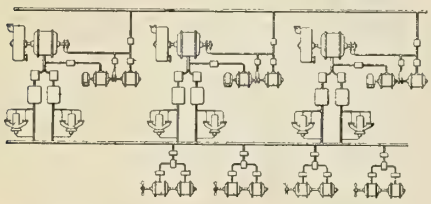
American patents, compiled by George A. Hutchinson, Esq., registered patent attorney, Washington Loan and Trust Building, Washington, D. C.

1,244,762. METHOD OF CONSTRUCTING THE HULLS OF SHIPS. PHER H. NELSON, OF DULUTH, MINN.

Claim 1.—A ship hull comprising a plurality of ribs, planking supported therefrom and a filling of cement between said ribs, some of which cement extends into spaces betwen the planks of the planking and against which the planking presses when said planking swells under the action of water. Five claims.

1,262,497. ELECTRICAL SYSTEM OF SHIP PROPULSION. HENRY M. HOBART OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY.

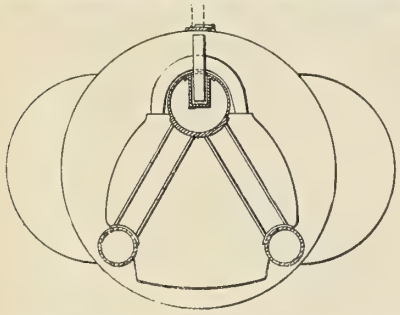
Claim 1.—An electrical system of ship propulsion comprising in combination an elastic fluid turbine, a polyphase alternator coupled to said turbine, electric current rectifying means electrically connected to said alternator



and adapted to convert the alternating current energy generated by said alternator to high potential direct current energy, a plurality of propellers, a direct current electric motor directly coupled to each of said propellers and supplied with said high potential direct current energy, and means for varying the speed of the ship by varying the field strengths of said motors. Four claims.

1,260,848. FUNNEL OF SUBMARINE VESSELS. HAROLD E. YARROW, OF GLASGOW, SCOTLAND.

Claim.—A telescopic funnel for a submarine vessel adapted to be lowered when the vessel



is submerged into a housing provided in the steam drum.

1,263,052. TUNNEL-BOAT. CARL H. FOWLER, OF NEW YORK, N. Y.

Claim 1.—A boat having a series of tunnel chambers open at the bottom and longitudinally arranged, shafts extending info said chambers

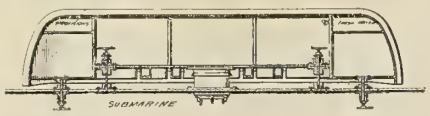
from the interior of the boat, propellers thereon within said chambers, power-generating means, and connections between the same and said propeller shafts. Five claims.

1,239,978. APPARATUS FOR INDICATING THE SPEED OF SHIPS. RICHARD STAR, OF NEWPORT, R. I.

Claim 1.—In an apparatus the combination with an indicator, of means for controlling the same comprising an actuator composed of three superposed expansible chambers, that is a pressure chamber, a suction chamber, and an intermediate chamber charged with liquid and provided with a movable head, an inlet pipe opening into said pressure chamber and communicating with the water of flotation, a suction pipe opening into said suction chamber and also communicating with the water of flotation, and a stand pipe adapted to contain a column of liquid connected to said liquid chamber, for balancing the pressure on said movable head. Seventeen claims.

1,259,534. SUBMARINE LIFE-BOAT. ST. CLAIR LEWARK, OF MAMIE, NORTH CAROLINA.

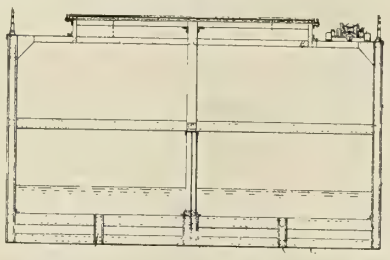
Claim 1.—The combination with a submarine, of a lifeboat inverted and detachable means secured thereon, said lifeboat and submarine having telescoping tubular extensions projecting therefrom and providing for communication therebetween, each of said tubular extensions



being provided with a packing ring at its inner end to receive the outer end of the opposite extension, and each being provided with an inwardly projecting flange having an annular rib around its inner edge, a hatch or cover for each of the extensions provided with a packing ring to receive the rib of its respective flange, and securing means at the inner and outer sides of each of said flanges for engagement with the hatches or covers at the inner and outer sides of the latter. Nine claims.

1,259,540. SHIP CONSTRUCTION. ALEXANDER McDOUGALL, OF DULUTH, MINNESOTA.

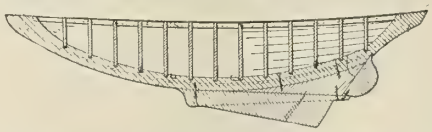
Claim 1.—The combination with a ship's hull substantially rectangular in cross section, having an inner bottom or tank top therein and thwartship beams intermediate the tank top and the uppermost deck beams, of a fore and



aft bulkhead extending from the tank top to the underside of the thwartship beams, stanchions intermediate the thwartship beams, resting upon the bulkhead and extending upwardly above the uppermost deck beams, and a continuous elevated hatch trunk extending the full length of the cargo hold of the ship supported at its sides upon the uppermost deck beams and at its center upon the stanchions. Ten claims.

1,259,572. BOAT-HULL. URQUHART WILCOX, OF BUFFALO, NEW YORK.

Claim 3.—A boat hull comprising a backbone having a keel, a stem post at the front end of the keel, said keel having curved rabbets on its laterally opposite sides and curved upper and lower sides, all of which are concentric except at the extremities thereof and said



stern and stem posts having their upper and lower sides diverging outwardly and provided on laterally opposite sides with rabbets which are curved on a shorter radius than the upper and lower sides and rabbets of the keel ribs mounted on said keel, and a skin applied to said backbone and ribs and fitted in said rabbets. Ten claims.

1,259,627. SUBMARINE LIFE BOAT. ERNEST P. HOWE, OF CLINTON, MASSACHUSETTS.

Claim 1.—The combination with a submarine and a lifeboat therefor, of means to detachably secure said boats together, said means comprising a plurality of pins mounted in said lifeboat and adapted to enter corresponding pockets in said submarine, racks connected to said pins, pinions engaging said racks to move said pins axially, arms connected to said pinions, links connected to said arms and means to move said links simultaneously to withdraw said pins. Six claims.

1,246,771. STEAM-CONDENSING PLANT. DONALD BARNES MORISON, OF HARTLEPOOL, ENGLAND.

Claim 1.—Apparatus comprising a number of steam operated ejectors (exceeding two) arranged in series for withdrawing from a low pressure and discharging to a higher pressure, said ejectors being so constructed that the degree of compression in each successive stage of compression, from the lower to the higher pressure, is greater than in the preceding stage. Sixteen claims.

1,246,968. DETACHABLE MEANS FOR LIFEBOATS. JOHN ALEXANDER McNABB, OF COLLINGWOOD, ONTARIO, CANADA, ASSIGNOR OF ONE-THIRD TO GEORGE TINEGATE.

Claim 1.—The combination with a boat; standards supported one at each end thereof; a coupling hook pivoted to each of the said standards, and having its free end projecting thereabove; and means whereby said coupling hooks may, under suitable conditions, be moved to uncouple the boat from the coupling members supported by the davits; of a keeper pivoted to each of said standards; and means whereby said keepers are locked to maintain them normally in the path of releasing movement of said coupling members. Two claims.

1,250,235. SEPARABLE-TORPEDO CONSTRUCTION. HAROLD W. SHONNARD, OF UPPER MONTCLAIR, N. J., ASSIGNOR TO CRUCIBLE STEEL COMPANY OF AMERICA.

Claim 1.—In an automobile torpedo, the combination of adjoining separable fore and aft shell sections, a separable fluid conduit leading from the one to the other of said sections, one conduit part being secured to each shell section, a conduit-coupling head attached to each conduit part, and a rotatable connecting member engaging said heads, one of said shell sections being provided with an opening adjacent to said member, and said member being provided with a head engagable for continuous rotation by a tool inserted through said shell opening. Three claims.

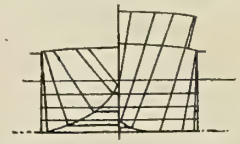
1,260,978. DEVICE FOR CLOSING OPENINGS IN THE HULLS OF VESSELS BELOW THE WATER-LINE. CONRAD STEWART HENSLEE, OF NORTH CHATTANOOGA, TENNESSEE.

Claim 1.—In a device for closing openings below the water line in the hull of a vessel, a closure member adapted to be firmly held pressed by water pressure against the hull of a vessel to close an opening therein a plurality of cups connected with the closure member operable under the influence of water passing through said opening to guide the closure member into position to close the opening, and a flexible reinforced plate to underlie said closure member and opening engageable with the vessel. Six claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

110,516. "IMPROVEMENTS IN AND RELATING TO CONSTRUCTION OF SHIPS." W. D. McLAREN, G. M. WELSH AND J. G. JOHNSTONE, ALL OF GLASGOW.

The object of this invention is to construct a ship with transverse members so that each member is straight, and that the plates are attached to the members with no distortion from a plane surface other than that involved in slight twisting and bending of the plates between the members. A shell plate may be readily given this slight deformation when cold, and consequently the work of framing and plating the ship is of a simpler nature than that required for ships of ordinary shape. One manner in which the invention may be carried out is shown in the drawing. It will be observed that the half section of the ship at any station is represented by two straight lines.



One line is a section through the bottom of the vessel, and the other a section through the side. These two lines are shown intersecting at a point which ..es on a knuckle extending throughout the length of the ship. The construction in way of the knuckle may be made of an angle bar having the side plating riveted to one flange and the bottom plating to the other. The knuckle may, however, be made in any other manner, such as by flanging the side plate to the bottom plate, or *vice versa*, or by introducing a curved plate of small width instead of the above-mentioned angle bar. It will be observed that there is only a single knuckle on each side of the ship, and that straight floors are laid transversely from knuckle to knuckle.